

# **SANTA CRUZ LABORATORY PROGRAM REVIEW 2002**

**December 3, 2002**



**U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Southwest Fisheries Science Center  
Santa Cruz Laboratory  
110 Shaffer Road  
Santa Cruz, CA 95060**



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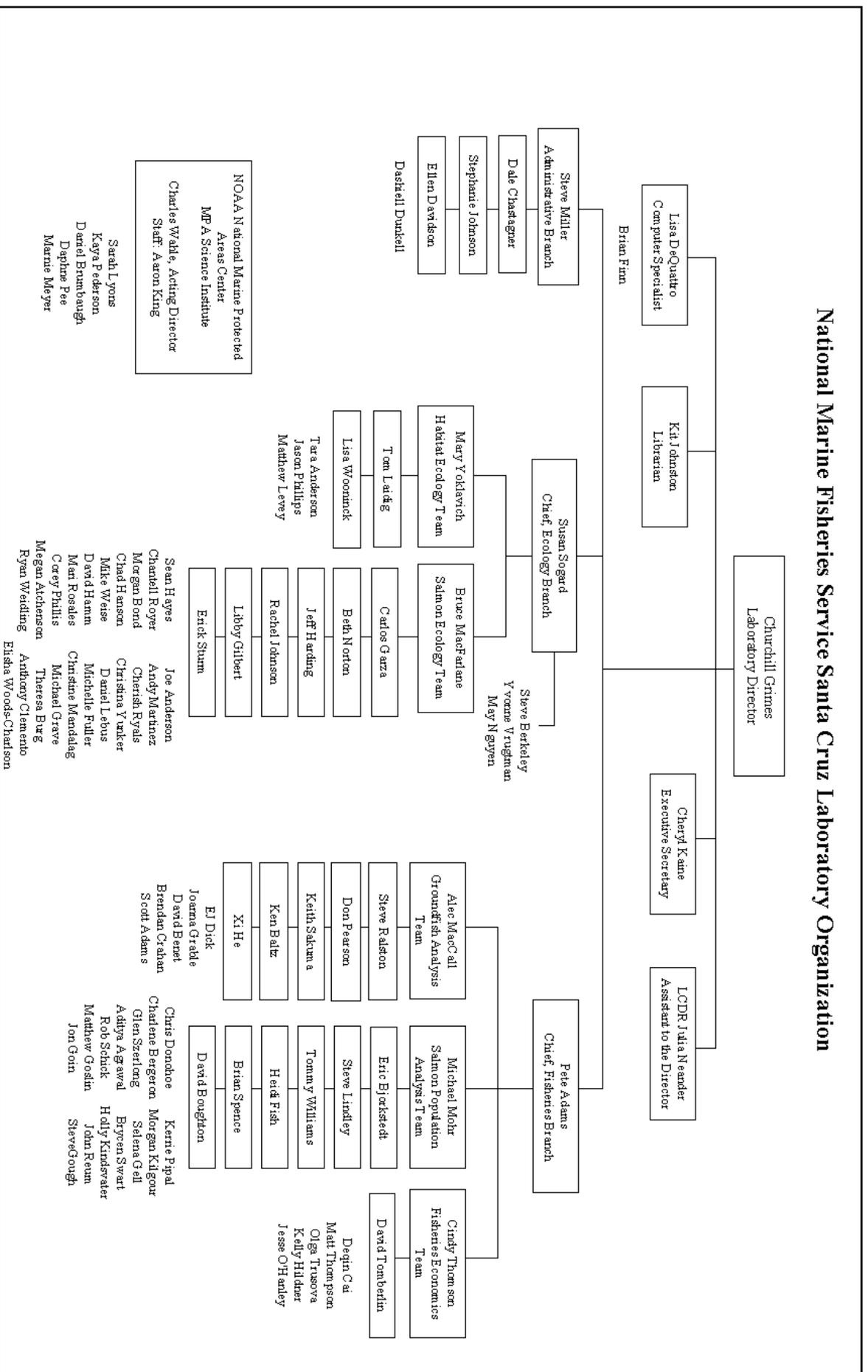


**AGENDA**  
**December 3, 2002**

I.	Welcome and Introduction . . . . . Grimes	0830 - 0900
II.	Research Program Presentations	
	1. Fisheries Branch	
	Groundfish Team . . . . . MacCall	0900 - 1000
	Stock Assessment, Field Surveys, CSTAR	
	 <b>BREAK</b>	 1000 - 1030
	Salmon Team	
	ESA Support Activities . . . . . Adams	1030 - 1115
	Harvest Management . . . . . Mohr	1115 - 1130
	Economics . . . . . Thomson	1130 - 1200
	 <b>LUNCH</b>	 1200 - 1330
	2. Ecology Branch	
	Early Life History Team . . . . . Sogard	1330 - 1400
	Salmon Ecology Team	
	Salmon Ecology . . . . . MacFarlane	1400 - 1430
	Genetics . . . . . Garza	1430 - 1500
	Habitat Ecology Team . . . . . Yoklavich	1500 - 1530
	 <b>BREAK</b>	 1530 - 1600
III.	Comments from the Science Director	1600 - 1630
IV.	Discussions with the Science Director	1630 - 1730
	 <b>ADJOURN</b>	 1730



# National Marine Fisheries Service Santa Cruz Laboratory Organization





## **Organization, Programs, Partnerships and Facilities**

### **Organization**

The National Marine Fisheries Service (NMFS) is a division of the National Oceanic and Atmospheric Administration (NOAA), which resides in the United States Department of Commerce. NMFS can be referred to as NOAA Fisheries. The field operations in NMFS are divided into 5 geographic regions. The southwestern U.S. and Pacific Islands fall within the jurisdiction of the Southwest Region (SWR), headquartered in Long Beach, California and the Southwest Fishery Science Center (SWFSC) located in La Jolla, California.

The Santa Cruz Laboratory is one of four laboratories comprising the SWFSC. In addition to La Jolla and Santa Cruz, the other laboratories are located in Honolulu, Hawaii and Pacific Grove, California. The Director of the Santa Cruz Laboratory, Dr. Churchill B. Grimes, reports to Dr. Michael Tillman, Science Director of the SWFSC, through his deputy Dr. Richard A. Neal.

### **Core Research Program and Partnerships**

The research program of the Santa Cruz Laboratory is focused in two primary areas: 1) biological and economics research supporting the restoration and recovery of threatened and endangered salmon in California, e.g., distribution and abundance, population dynamics and extinction risk, genetics, ocean and estuarine ecology of juveniles, and ocean habitat utilization by adults; 2) the biological basis of rational management of west coast groundfish resources, e.g., population dynamics and stock assessment, recruitment processes, habitat ecology and marine protected areas.

Cooperative relationships with other organizations assist the laboratory in accomplishing the research mission. The laboratory houses the National Marine Protected Area Center (NMPAC) Science Institute. Created by a Presidential Executive Order in 2000, the NMPAC is a partnership between two NOAA agencies, NMFS and the National Ocean Service (NOS). The NMPAC supports research relevant to siting, evaluation and implementation of MPAs for conservation and management of a variety of cultural and biological resources. The principal academic partner of the laboratory is the University of California at Santa Cruz (UCSC) with whom laboratory scientists conduct many collaborative research projects, and participate in graduate academic programs through courtesy faculty appointments. The Center for Stock Assessment Research (CSTAR) is a special feature of the partnership with UCSC. Other research partners include United States Geological Survey, the University of California at Santa Barbara, Moss Landing Marine Laboratories, Humboldt State University, California State University Monterey Bay, Duke University, California Department of Fish and Game and the Monterey Bay Salmon and Trout Project.

### **Facility**

The NMFS laboratory at Santa Cruz that replaced obsolete facilities at Tiburon, California was occupied in December 2000. The new state of the art 53,400 square foot facility includes:

office accommodations for approximately 44 administrative and scientific staff; ultramodern biological and chemical laboratories that support cutting-edge analytical approaches ,e.g., in biochemical genetics and otolith micro structural and micro chemical analysis; latest information technology infrastructure, e.g., copper and fiber-optic cable drops in nearly every work space, LAN of latest PC and workstation platforms and peripherals to support computationally intense modeling analyses, connectivity to University of California system-wide networked assets such as on-line journals; environmentally friendly design; experimental seawater and freshwater aquarium systems with digital control of environmental conditions and extension of seawater to exterior spaces where large volume experiments can be conducted; digital and motion sensor control of the environment in all interior spaces; digital imagery laboratory for analysis of *in situ* video, acoustic and electro-optic imagery for seafloor mapping and GIS georeferencing and layering.

### Santa Cruz Laboratory Relocation

#### Construction Milestones

Summer 2000	Framing, roofing, and infrastructure completed
Fall 2000	Dedication ceremony held, exterior painting & paving completed, office furniture installed
December 2000	Occupancy of Administration and Office wings, interior finish work and landscaping
Summer 2001	Final acceptance of entire building
June 2002	Surge areas - eight offices, 16 cubicles, and two labs completed
To be completed February 2003	Captive Broodstock Facility
To be completed June 2003	Seawater Intake System

#### Tiburon Closure

March 2001	Substantial move-out completed
August 2001	Environmental cleanup certified
October 2001	SFSU issued License for Use
Pending	Final Excess process through GSA

Since occupation of the new facility in December of 2000 a number of improvements have been completed. An additional eight offices and sixteen office cubicles and two laboratories were constructed in unfinished space on the second floor over the warehouse and aquarium, respectively. Additional improvements include carpet installation in all common areas, and the surfacing and finishing of unattractive wall surfaces in the entrance foyer. Planned or underway improvements include enhanced natural landscaping, additional parking along the west wing of the laboratory and construction of a captive broodstock facility in the courtyard between the center and west wings of the laboratory.



## **FISHERIES BRANCH**

The Fisheries Branch brings together the management-related tasks within the Santa Cruz Laboratory, and due of this, is heavily oriented toward quantitative population biology. The Branch also carries out basic research into the underlying biological mechanisms that control the population dynamics of the fishes under consideration, as well as research directed toward critical information needs. The Branch is heavily involved with NMFS's responsibilities with the Endangered Species Act (ESA) and the Pacific Fisheries Management Council (PFMC). The Branch consists of the Salmon Population Analysis Team, the Economics Team, and the Groundfish Analysis Team.

### **Salmon Population Analysis Team**

#### **Introduction**

The scientific focus of the Salmon Population Analysis Team (SPAT) is to understand the population dynamics of both endangered and exploited salmonid stocks in California. The Team conducts quantitative studies incorporating population life-history characteristics, population estimation, and modeling. Implicit in this scientific focus is management application. The largest commitment is in support of activities mandated by the ESA. The Team has participated in all Listing activities within the Southwest Region, the creation of Technical Recovery Teams for Southwest Recovery Domains, and provided guidance and input on numerous other endangered species issues and activities. The need for information and advice on endangered species issues appears to be infinite. The other major Team responsibility is in salmon harvest management. The Team supports the PFMC through participation in the PFMC's Salmon Technical Team and the Klamath Fishery Management Council (KFMC) through participation in the KFMC's Klamath River Technical Advisory Team.

The Team is a recent addition to the SWFSC and is still developing its capacities. The coastwide declaration of anadromous salmonids as candidate species under the ESA in 1992 created a tremendous demand for salmon information and analysis. By 1995, the need was so pressing that personnel at the (Tiburon) Laboratory were reprogrammed to develop a SWFSC salmon research capacity. The program has grown rapidly and has eight permanent FTEs and six vacant FTEs. Much of the Team's research is both novel and still in its initial stages, and will require the development of new and original methods.

## Objectives

The Salmon Population Analysis Team’s goal is to conduct the research needed to support salmonid ESA and Council harvest activities. In addition, the Team conducts basic research that will provide the underlying theoretical structure of these activities to improve salmon management in the future. More specific goals are:

- to collect or to coordinate collection of critical population distribution and abundance data needed for assessments of salmonid populations;
- to establish appropriate and statistically robust survey methods and population estimators for use in salmon research and management;
- to investigate critical salmon life-history characteristics (abundance, distribution, mortality, straying, etc.) needed for a comprehensive management approach to Pacific salmon and steelhead;
- to develop methods for modeling population viability and metapopulation dynamics for use in ESA assessments;
- to provide salmon harvest management guidance, through modeling and focused biological studies, to the Councils (PFMC and KFMC), SWR, and other appropriate groups; and
- to provide scientific expertise to the SWR and other appropriate groups.

## ESA Assessment and Support

### *Technical Recovery Planning*

Recovery planning for listed Evolutionarily Significant Units (ESUs) of salmon and steelhead has been organized around geographically defined Recovery Domains and is structured into two phases, with Phase I being a scientific process intended to inform and support development and implementation of recovery actions during Phase II. For each Domain, a Technical Recovery Team (TRT) will develop biological recovery criteria for all listed ESUs encompassed in the Domain. The general charge to each TRT is to:

- Identify independent populations, as defined in the “Viable Salmonid Population” (“VSP”) document;
- For each independent population, assess its status and identify criteria based on abundance, productivity, spatial structure and diversity which, if met, would imply that the population is viable—that is, it has an acceptably small (5%) probability of extinction over a 100 year time frame in the face of “normal” environmental variability;

- Identify various configurations of independent populations based on viability status, location, and diversity that would yield negligible extinction risk for the ESU in the face of local or regional catastrophes, maintain the evolutionary potential of the ESU, and thus provide suitable delisting criteria;
- Identify and provide guidance to research and monitoring efforts to collect data needed to reduce critical uncertainties and to assess the progress and success of recovery efforts.

While substantial efforts are being made to ensure consistency among TRT analyses and approach along the coast, the manner in which TRTs fulfill these charges will, to a large degree, depend on the quality of the data available for analysis. Subsequent to, and indeed during the latter stages of, developing technical recovery criteria, TRTs will interact with Phase II recovery teams as the latter develop recovery plans.

Scientists at the Santa Cruz Laboratory participate, or will participate, on four TRTs, each of which is chaired by a member of the SPAT. TRTs were established in October 2001 for two Recovery Domains in coastal California:

- The Southern Oregon-Northern California TRT (SONC-TRT), which will develop technical recovery criteria for the Southern Oregon-Northern California ESU of coho salmon (members of this TRT will also participate on a sub-TRT formed recently to develop recovery criteria for the Oregon Coast ESU of coho salmon); and
- The North-Central California Coast TRT (NCCC-TRT), which will develop recovery criteria for the following ESUs: Central California Coast coho salmon, California Coastal chinook salmon, Northern California steelhead, and Central California Coast steelhead.

The Recovery Domains for these TRTs overlap in the region between the Mattole and Klamath rivers, which has required substantial coordination in activities. Two more teams are being established in the near future:

- The Central Valley TRT (CV-TRT), which will develop technical recovery criteria for the following ESUs: Central Valley Spring chinook salmon, Sacramento River Winter chinook salmon, and Central Valley steelhead; and
- The Southern California Coastal TRT (SCC-TRT), which will develop technical recovery criteria for the South-Central California Coast and Southern California Coast steelhead ESUs.

Nominees to the CV-TRT are currently in review by an independent committee established by the CalNeva chapter of the American Fisheries Society; it is expected that this TRT will begin work this fall.

To date, the SONC-TRT and NCCC-TRT have focused on assembling and analyzing available data to identify independent populations comprising each ESU. Due to the lack of a coordinated mechanism for data collection and assembly in California, this effort has consumed

considerable time and energy, and is expected to continue to do so over the next year. As sufficient information is assembled to support population delineation for an ESU, concurrent efforts will focus on: (1) assessing the viability of each independent population and determining what criteria, in terms of abundance, productivity, spatial structure and diversity, must be met for each to be considered viable; and (2) determining, with a particular focus on spatial distribution and diversity, how many and which independent populations are necessary for the ESU as a whole to have a negligible chance of extinction in the foreseeable future. In parallel with these analyses, the TRTs are developing recommendations for relevant research and monitoring efforts to collect data necessary to reduce uncertainty, and to test hypotheses in cases where available data do not suffice to differentiate among plausible scenarios. Anticipated (and intentionally aggressive) timelines for completion of Phase I TRT tasks range from late 2003 (SONC-TRT) to mid-2004 (NCCC-TRT). The CV-TRT and SCC-TRT will benefit from infrastructure developed during the past year, yet are expected to require 18-36 months from establishment to completion of TRT tasks.

To support technical recovery planning activities, we have implemented a Geographical Information System (GIS) capability, assembled a team of four analytical support staff to increase our ability to conduct rigorous statistical analyses in a spatially explicit framework, and assembled a team of four additional support staff to assist in obtaining, assembling and organizing available data from a broad range of sources within each TRTs' Domain. Numerous environmental and habitat-related data sets have been obtained and incorporated into the GIS, and current efforts are focused on assembling distribution and abundance information on salmon and steelhead in the GIS. Dynamic segmentation will be implemented to provide a straightforward means for linking data on salmon distribution and abundance to environmental variables. By supporting such associations, GIS will facilitate analyses to estimate habitat availability (historic and current), factors affecting population size, measures of connectivity among and within watersheds, and other information relevant to recovery planning and development of efficient research and monitoring programs.

### **Green Sturgeon Status Review**

NMFS received a petition to list green sturgeon (*Acipenser medirostris*) under the ESA, and it was the responsibility of the Santa Cruz Laboratory to establish a Biological Review Team (BRT), conduct the Biological Review, and prepare the Status Review. The BRT was composed of Dr. Peter Adams, Dr. Churchill Grimes, and Dr. Steve Lindley of the Santa Cruz Laboratory, Dr. Joe Hightower, USGS Fish and Wildlife Research Unit, North Carolina State University and Dr. Mary Moser, NMFS, Northwest Fishery Science Center. Green sturgeon have an anadromous life history and are only known to spawn in three river systems; the Rogue, the Upper Sacramento, and the Klamath where 80-90% of the population is thought to spawn. Eggs are spawned over rocks and cobble bottom in the upper river systems between March and July. Eggs hatch among the rocks, grow into larvae and juveniles. Temperatures above 20° C are lethal to embryos in laboratory experiments. Juveniles grow rapidly reaching 305 cm (2 feet) within 2-3 years, and spend 1-4 years in freshwater before migrating to the ocean. Green sturgeon spend more time in the ocean than any other sturgeon. They return to freshwater for first spawning after 15 to 17 years, and then only spawn every 3-5 years. An unusual aspect of their life history

is that they concentrate in coastal estuaries in summer and fall months. The reasons for these concentrations are unknown, but it makes green sturgeon vulnerable to fisheries, particularly in the Columbia Basin.

The green sturgeon Status Review needed to answer two questions: 1) Is green sturgeon a species under the ESA, and if so are there Distinct Population Segments (DPSs)? and 2) What risk of extinction does green sturgeon face? The North American form of green sturgeon is clearly a species under the ESA. In the past, green sturgeon were considered to occur from Southern California around the Pacific Rim to China. Recently, the species was separated into a North American species, green sturgeon (*A. medirostris*) and an Asian species, Sakhalin sturgeon (*A. mikadoi*), based on total chromosome number and number of replicate chromosomes (i.e., ploidy levels). The BRT further divided the population into two sub-units; a northern and a southern DPS. This was based on the fact that sturgeon typically have small-scale genetic population structure and that preliminary genetic data from the University of California, Davis showed differences between the Klamath River and San Pablo Bay samples in both unique alleles and allele frequency. The northern DPS includes the Rogue and Klamath rivers, and the Eel River if green sturgeon spawn there. The southern DPS includes fish from the Sacramento-San Joaquin river system. The only known spawning in the southern DPS is in the upper Sacramento River. The boundary between the two DPSs is somewhat arbitrary based on geography, and there well may be additional green sturgeon DPSs when additional data are available.

The green sturgeon BRT was unable to reach conclusions about the population status due to lack of population trend data, but was concerned about the high level of risk faced by the species. Risk factors include concentration of spawning in the Klamath River, harvest of an unknown portion of the population, and lack of significant population trend data. The BRT was particularly concerned by the apparently unfounded assertion of co-managers that green sturgeon populations were stable or increasing. However, without data clearly indicating decline, the BRT recommended that green sturgeon should remain in candidate status with a review within five years to evaluate if any new population trend information or if any of the risk factors have changed.

### **Research and Other Activities**

- *Recovery Science Review Panel Meeting, Santa Cruz Laboratory, 18-20 March 2002* – The Santa Cruz Laboratory hosted the March meeting of the Recovery Science Review Panel (RSRP), a group of eminent ecologists charged with providing guidance and independent review of the science that underlies development of biological recovery criteria for listed anadromous salmon and steelhead ESUs. The meeting agenda focused on technical recovery planning efforts in California, and particularly at the Santa Cruz Laboratory. Laboratory scientists presented overviews of relevant contrasts between the Pacific Northwest and California with respect to the ecology and environment of anadromous salmonids, and the scope and quality of data available to support scientific analysis. Scientific presentations by invited speakers included talks on: (1) the historical and current susceptibility of watersheds to disturbance; (2) the ecological and evolutionary implications of harvest for chinook

salmon; and (3) a review of genetic studies relevant to interactions and relationships between anadromous steelhead and nonanadromous rainbow trout. Laboratory scientists presented works-in-progress on analyses of: (1) spatial pattern and trends in the distribution of coho salmon; and (2) spatial and temporal correlations in flood-related disturbance in northern coastal California. Discussion among the RSRP and meeting attendees focused largely on the limited nature of the available data and what conclusions such data could support; for the most part, it was suggested that sophisticated, highly quantitative technical recovery planning may be a bit premature, and that substantial effort and attention should be given to developing precautionary recovery goals, and to directing efforts to collect sufficient rigorous data needed to refine precautionary recovery goals.

- *Coho salmon population ecology* – Since 1998, members of SPAT have been collaborating with researchers at Humboldt State University on a long-term project designed to examine the impact of habitat factors in northern California streams on survival of coho salmon during the freshwater phase of the life history. Currently, we are near the end of the third full year of sampling, and have collected information on: (1) abundance and distribution of spawners, redds, juveniles, and outmigrating smolts in three streams ranging in condition from pristine to recently disturbed by logging or landslides; (2) the use of overwintering habitats by juvenile coho salmon, and the consequences of different habitats for growth and survival; (3) the existence of a life-history variant in which approximately 20% of the juveniles spend a second winter in freshwater, and which was previously undocumented in California; and (4) variation in fry production from redds as a function of habitat quality. The core of this work will continue for the next two to three years to span an entire life-cycle of coho salmon, and to allow us to develop estimates of temporal variability in survival and production during the freshwater life history of coho salmon. Coincident research projects have been initiated to investigate: (1) the spatial prevalence of and possible ecological causes and consequences of variation in freshwater residence time; (2) patterns in the distribution of juvenile coho among habitats and the implications of such patterns for uncertainty in presence-absence surveys; and (3) the mechanisms driving juvenile movement and redistribution among habitats of varying quality.
- *Improvement of downstream migrant trapping technology* – Trapping of juvenile salmonids during their downstream migration is a widespread practice for estimating production and abundance of anadromous fish in streams. Operated properly, such traps cause minimal mortality, on the order of one percent. However, these estimates do not account for in-trap predation, which has not been investigated quantitatively. In recent field work, collaborators at Humboldt State University have found that coastal cutthroat trout in live boxes of outmigrant traps consume substantially more juvenile coho and chinook salmon than do coastal cutthroat trout at large in the stream. This discovery has led to efforts to design and evaluate the performance of new trap configurations that efficiently and effectively segregate large, potentially predatory, fish from juvenile salmonids as a way to reduce predation mortality in traps. Experimental field trials, associated *in situ* surveys of at-large predators, and gut analyses are nearly completed, and preliminary observations suggest that a full mesh live box with a mesh divider panel is effective in segregating trapped fish by size.

- *Genetic evaluation of visual identification of steelhead, cutthroat trout and their hybrids* – In contrast to surveys conducted for juvenile coho salmon, surveys designed to estimate juvenile abundance of sympatric steelhead and cutthroat trout are limited by the virtual impossibility of distinguishing the two species and their hybrids during visual snorkel surveys. There is similar confusion in identification of individuals handled during electrofishing surveys. In conjunction with researchers at Humboldt State University, we use genetic markers to evaluate the effectiveness of visual discrimination of juvenile trout into steelhead, cutthroat trout or hybrids, as is typically done in the field. Samples were collected from sympatric populations in northern California. During collection, experienced field biologists independently sorted individuals into five categories ranging from “definitely steelhead” to “definitely cutthroat trout”. Results to date indicate surprisingly frequent hybridization and back-crossing among cutthroat trout and steelhead in the systems examined thus far. Analyses comparing visual and genetic identifications indicate that a substantial number of true steelhead may be visually misclassified as hybrids, but almost no hybrids or true cutthroat trout are visually misclassified as steelhead. Hybrids are generally misclassified as pure cutthroat trout, a result that might have serious consequences if survey objectives were to estimate the numbers of pure cutthroat trout in a stream that contained steelhead, cutthroat and their hybrids.
- *Relationships between Resident and Anadromous Forms of *Oncorhynchus mykiss** – *Oncorhynchus mykiss* exhibits both non-migratory (resident rainbow trout) and anadromous (steelhead) life-history forms, but the relationship between the two forms is unclear. Resident fish may produce anadromous offspring and vice versa, but in some systems the two forms appear to be reproductively isolated. Resident forms are generally excluded from ESA listings of steelhead, but this policy is under review. We are using otolith strontium to calcium (Sr:Ca) ratios to distinguish life-history forms since marine environments are enriched in strontium. This information is used to estimate the proportion of fish which are descended from females of the alternate life history form, and thus the degree of reproductive isolation. At present, samples from steelhead hatcheries in California are being analyzed to confirm anadromy of broodstock, and evaluate the use of scales and fin rays as non-lethal alternatives to the otolith-based method. Results of this research will provide guidance on whether and how to include resident fish in steelhead ESUs, and in models to estimate viability of steelhead populations in California.
- *Presence-Absence survey of steelhead in the Southern California Recovery Domain* – Very few data exist for steelhead in coastal streams south of Santa Cruz, despite the fact that the area contains two steelhead ESUs that are listed as threatened or endangered. We are working to improve our knowledge of this region, by conducting a synoptic study of steelhead presence/absence in as many coastal streams as possible of the Southern California Recovery Domain. This domain runs from the Pajaro River Basin, which empties into Monterey Bay, south to the border with Mexico. The area south of Malibu Creek (northern Los Angeles County, south to Mexico) has only recently been recognized by NMFS as a component of the natural range of the species, and so data from that area in particular are extremely valuable. Presence or absence of steelhead in a stream is assessed by conducting up to three snorkel surveys in that stream, using a predefined protocol to standardize effort

per stream. Presence of steelhead can be interpreted unambiguously, but absences can either mean that the steelhead are truly absent, or that they were present but not detected. Thus, the results of this study will be regarded as preliminary. The study should provide a snapshot assessment of steelhead distribution in southern California for the year 2002. The fact that this year is the driest year on record in Southern California gives us an added benefit of assessing steelhead distribution under what are probably the worst possible conditions for its persistence. This will aid us in implementing the precautionary principle during the development of recovery criteria.

- *Preliminary work on metapopulation modeling* – It seems quite likely that at the southern limits of their ranges, both coho and steelhead may occur as metapopulations. A metapopulation is a system of populations in which no single population is protected from extinction; persistence of the system as a whole depends on recolonization of sites at which populations have gone extinct. The evidence for such dynamics is circumstantial, and based on anecdotal data. Presence/absence data collected under some sort of sampling frame would be preferable, especially for the development of metapopulation models that might be used for risk assessment or for recovery planning. However, the design of the most efficient sampling frame is unclear. We have conducted a series of computer simulations to assess the efficacy of various sampling frames for collecting presence/absence data. Three frames were examined: 1) site sampling, in which individual sites are randomly selected at the start of a study, and then consistently sampled thereafter; 2) point sampling, in which sites are randomly sampled every year of the study; and 3) generational sampling, in which half the sites are randomly sampled every generation, and the other half are revisits of sites sampled exactly one generation earlier. Although point sampling is the frame that most resembles existing data, it is also the frame that is least useful for metapopulation modeling. Site sampling and generational sampling gave vastly better results, and allowed for much simpler analytical methods in their analysis.
- *Development of a Monitoring Plan for Salmon Recovery* – Currently, there is no comprehensive monitoring of coastal salmonids at the basin- or regional-scale in California. Yet it seems likely that if delisting is to ever occur, such monitoring must be developed and implemented. Without it, we will have no data on salmonid trends and abundance in the future, which will mean that any delisting action would be vulnerable on scientific grounds. The first step in developing such monitoring is a monitoring plan. In collaboration with the California Department of Fish and Game (CDFG), we have developed a proposal to develop a monitoring plan for salmonids in the coastal region of California (i.e., all ocean-connected streams except the Sacramento/San Joaquin system above the Carquinez Straits). The proposal was submitted to the Habitat Restoration Grants program of CDFG. If funded, it will consist of a series of workshops with participation of scientists from NMFS Santa Cruz Lab (including the four TRT chairs), CDFG, academia, and the Oregon Department of Fish and Wildlife. The goal is to produce a monitoring plan which will be implemented by CDFG for the purpose of providing data on salmonid trends and abundance into the future.
- *Estimation and forecasting of winter-run chinook juvenile production* – We are developing a statistical model for estimating and forecasting winter-run chinook abundance by life-stage

from a diverse observation series. The model consists of two parts: a stochastic, stage-structured model of the chinook life cycle, and a model of the observation system that accounts for observation error and accommodates multiple observation series (e.g., counts of adults passing a dam and counts of juveniles in an outmigrant trap). The method is supported by state-space time series analysis theory and relies on recently developed, simulation-based estimation procedures. Currently, research is focused on simulation studies examining estimation performance under different data scenarios, and has shown that determining the age and sex of adult winter-run chinook would be a valuable improvement for monitoring. If the method proves practical, it will be applied to the problem of predicting and estimating the number of juvenile winter-run chinook arriving in the Delta, an important estimate which is used in setting jeopardy standards for water operations and research activities in the Delta. The model may also be useful for management of ocean fisheries that impact winter-run chinook by providing a preseason forecast of abundance.

- *Geographic variation in genetic and meristic characters of coastal cutthroat trout* – This research project examines the geographic variation in genetic and meristic characters of coastal cutthroat trout (*Oncorhynchus clarki clarki*), and lays the conceptual framework for understanding how habitat variability may interact at various spatial and temporal scales to shape the spatial distribution and persistence of populations. Coastal cutthroat trout provide an opportunity to examine how small populations persist in dynamic environments, since they exhibit a greater amount of variation in life-history and are characterized by many smaller, genetically more diverse local populations compared to other species of Pacific salmonids. This work, based on 56 populations sampled across the range from Alaska to California, includes the first range-wide description of the meristic and genetic variation in this sub-species. Genetic results based on 37 allozyme loci were consistent with the hypothesis that each sample was from an isolated population. In addition, the variation in allele frequencies among populations was much greater than that reported for other species of anadromous salmonids in western North America. Several of the meristic characters differ significantly among populations and have proven useful for detecting misidentified steelhead and suspected hybrid individuals of coastal cutthroat trout and steelhead.
- *Noyo River Studies* – This intensive study in the South Fork Noyo River (Mendocino County) includes juvenile salmonid distribution surveys, spawning and carcass surveys, adult return weir counts, and outmigrant trapping . The spawning and carcass surveys are done in collaboration with the California Department of Fish and Game (CDFG) and the adult return counts are conducted by the CDFG. The SPAT field crew has conducted single-pass direct-observation counts of approximately 30 kilometers of stream (pools and runs) over the past three seasons. With the completion of the 2002 survey, we have now sampled over the three-year life cycle of coho salmon, and subsequent year sampling will provide insight into tracking changes in numbers and distribution of individual brood lineages within the South Fork Noyo River. These data on the distribution and relative abundance of both juvenile coho salmon, along with the spawning distribution, estimated number of spawners, and downstream migrant estimates are part of an effort to understand the relationships among these various measures. An objective of this project is to provide empirical data about the spatial distribution and abundance of juvenile coho salmon and steelhead and spawning

activity in the complete sub-basin for modeling and simulation. Habitat information is also collected during summer juvenile surveys for examining habitat associations. In addition, this project is part of an effort to examine within basin straying of coho salmon released in other portions of the Noyo River basin. The adult spawners can be examined at the weir (CDFG Egg Collection Station) for various fin clips to assess if an individual is of wild or hatchery origin.

## **Harvest Issues and Council Support**

SPAT contributes directly to ocean salmon fishery management by: (1) conducting research on the models and estimation methods used by the PFMC and other entities to manage California's ocean salmon harvest; (2) providing scientific guidance to SWR Sustainable Fisheries Division on the development of Biological Opinions and NMFS harvest jeopardy standards for ESA-listed stocks; and (3) serving on the PFMC's Salmon Technical Team and the KFMC Klamath River Technical Advisory Team. Recent contributions in these areas include:

- *Klamath River Ocean Harvest Model* – This is a cornerstone model used by the PFMC in developing annual salmon harvest management regulations off the coasts of California and Oregon. A SPAT scientist led a recently concluded multi-year effort by NMFS, CDFG, and ODFW to overhaul this model and its input databases. The work included: (1) review and correction of catch, fishing effort, and escapement databases; (2) reformulation of the cohort reconstruction model to account properly for release mortality, drop-off mortality, natural mortality, and straying; (3) development of a size-at-age model; (4) estimation of historical harvest and maturation rates; (5) relating harvest rates to fishing effort; and (6) forecasting effort as a response to management regulations. The revised model was reviewed and implemented by the PFMC in 2002.
- *PFMC FMP amendment for Central Valley spring and winter-run chinook* – Central Valley spring and winter-run chinook salmon are listed as threatened and endangered, respectively, under the Endangered Species Act. Ocean salmon fishery impacts on these populations are currently regulated by the PFMC to meet NMFS Biological Opinion jeopardy standards, but NMFS has been encouraging the PFMC to take a more proactive role in the fishery management of these two populations. In response, the PFMC and NMFS recently formed a plan amendment group on which SPAT plays a major role, with a target plan amendment adoption date by the PFMC of September or November 2003.
- *Direct Council participation* – SPAT participates during all phases of the PFMC and KFMC annual salmon management process as members of the PFMC Salmon Technical Team and the KFMC Klamath River Technical Advisory Team. These duties include: (1) providing modeling and statistical expertise and recommendations on matters before the Councils; (2) modeling the effects of PFMC actions and regulations to evaluate compliance with the salmon FMP and ESU jeopardy standards; (3) producing reports for the PFMC documenting the data, models, forecasts, and regulations adopted each year, and the statistical data resulting from previous years' fisheries.

## **Publications**

- Bjorkstedt, E. P., L. K. Rosenfeld, B. A. Grantham, Y. Shkedy, and J. Roughgarden. In press. Distributions of larval rockfish (*Sebastes* spp.) across nearshore fronts in a coastal upwelling region. Marine Ecology Progress Series.
- Lindley, S.T. and M.H. Mohr. In Press. Predicting the impact of striped bass (*Morone saxatilis*) population manipulations on the persistence of winter-run chinook salmon (*Oncorhynchus tshawytscha*). Fishery Bulletin (US).
- Boughton, D. and U. Malvadkar. In press. Extinction risk in successional landscapes subject to catastrophic disturbances. Conservation Ecology.
- Grover, Allen M., Michael S. Mohr, and Melodie L. Palmer-Zwahlen. 2002. Hook-and-release mortality of chinook salmon from drift mooching with circle hooks: management implications for California's ocean sport fishery. Pages 39–56 in J. A. Lucy and A. L. Studholme, editors. Catch and release in marine recreational fisheries. American Fisheries Society, Symposium 30, Bethesda, Maryland.
- Salmon Technical Team. 2002. Review of 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.
- Klamath River Technical Advisory Team. 2002. Ocean abundance projections and prospective harvest levels for Klamath River fall chinook, 2002 season. Klamath Fishery Management Council, Yreka, California.
- Salmon Technical Team. 2002. Preseason report I: Stock abundance analysis for 2002 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.
- Salmon Technical Team. 2002. Preseason report II: Analysis of proposed regulatory options for 2002 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.
- Salmon Technical Team. 2002. Preseason report III: Analysis of council adopted management measures for 2002 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

## **Presentations**

- Hosted Recovery Science Panel Review of California Salmon Science at the Santa Cruz Laboratory.

## **Committees and Service**

- Served on Joint Scientific and Technical Team for California Department of Fish and Game's Steelhead Research and Monitoring Program.
- Eric Bjorkstedt was appointed as Adjunct Professor in the Department of Fisheries Biology at Humboldt State University.

## **Awards**

- Received on the Pacific Fisheries Management Council floor "Certificate of achievement for outstanding work to eliminate bias in fisheries management and for their outstanding achievement and perspicacity in the development of the new and improved KOHM", presented by the "Bias Abatement Council" (California ocean salmon trollers).
- NOAA Bronze Medal, for theoretical and methodological contributions which significantly advance the scientific basis for management of Pacific coast salmon resources, awarded to Michael Mohr.

**Program Development**

- Establishment of Technical Recovery Teams for the Southern Oregon/Northern California Coast Recovery Domain and the North-Central California Coast Recovery Domain. Nominations for the Central Valley TRT are being reviewed by a panel of the American Fisheries Society.
- Established green sturgeon Biological Review Team, conducted Biological Review, and produced Green Sturgeon Status Review Document.
- Lead multi-year collaborative NMFS, California Department of Fish & Game, and Oregon Department of Fish & Wildlife effort to implement a reformulated Klamath Ocean Harvest Model and associated databases.

## Economics Team

The Economics Team provides data, methods, and analyses needed to: (1) address economic issues associated with 4(d) rules and recovery plans for ESA-listed salmonid stocks; (2) devise practical approaches to addressing fishery management issues such as harvest overcapacity; and (3) develop models that predict the economic effects of regulatory restrictions on the salmon and groundfish fisheries. The goals of these economic studies are fundamentally the same as the SPAT biological studies, but the focus is on the human impact of ESA and fishery management actions rather than the biological impacts. The Team supports the PFMC by serving on the Scientific and Statistical Committee (SSC) and chairing the SSC Marine Reserve Subcommittee. The Team also serves on other technical advisory committees, disseminates research results, and reviews manuscripts and research proposals as requested.

### **Economic Activities in Support of Actions to Protect and Recover ESA-Listed Salmonids**

The Economics Team provides data and analyses to address economic requirements associated with agency actions to protect salmonids listed under the ESA. The Team's major focus in this regard is on estimation of habitat restoration costs associated with implementation of recovery plans.

- *Proceedings of the Salmon Habitat Restoration Cost Workshop* – The Team chaired a workshop to evaluate the feasibility of developing and applying standardized methods to estimate costs of restoring salmonid habitat. Workshop Proceedings - including 22 papers that discuss cost estimation issues associated with road maintenance and decommissioning, riparian restoration, instream treatment, fish screens and wetland creation and restoration - have been completed in collaboration with the Pacific States Marine Fisheries Commission (PSMFC).
- *California Salmon Habitat Restoration Project Database* – The Team continues to monitor development of the California Salmon Habitat Restoration Project Database (CHRPD), a database being created under a cooperative agreement with PSMFC. The CHRPD includes detailed information (e.g., project goals and description, location, project dates, monitoring, participants, land ownership, affected species and detailed budget information) on habitat restoration projects in California. The database is intended to facilitate salmon/steelhead recovery planning by (1) providing descriptive information on the nature, scope and location of existing restoration activities, and (2) providing data that will be used to estimate models that predict habitat restoration costs as a function of project characteristics, characteristics of habitat at the restoration site and local economic conditions. Substantial progress has been made on the CHRPD over the last year. The database now includes up-to-date information on all 2,200 restoration projects administered by CDFG's Fishery Restoration Grants Program since the 1970s. In addition, over 350 projects administered by the National Fish and Wildlife Foundation and 600 projects administered by the Coastal Conservancy are in the process of being entered into the database. Recruitment of a GIS specialist to assist with database enhancement and analysis is underway.

- *Application of operations research techniques to habitat restoration issues* – The Team is supporting two UC Berkeley graduate students under JIMO in: (1) developing stochastic dynamic optimization models to help assess whether to maintain or decommission roads when the objective is to enhance salmonid aquatic habitat conditions; and (2) evaluating the applicability of operations research techniques to the development of landscape-level models of optimal restoration strategies (e.g., how to best allocate restoration efforts among watersheds within an ESU). The first project is being conducted with data for the Casper Creek watershed provided by the U.S. Forest Service and Jackson State Forest.
- *Western States Small Business Database* – To support the evaluation of the effects of ESA 4(d) rules on small businesses, as required by the Regulatory Flexibility Act, the Team has created a database that describes the geographic distribution and size characteristics of business establishments in California, Oregon, Washington and Idaho that engage in activities (e.g., farming, forestry, mining) potentially affected by 4(d) rules. The database was recently updated to include the most recently available U.S. Census data (1998 and 1999) on county business patterns.
- *Salmon/steelhead freshwater angler survey* – NMFS is engaged in consultations with CDFG regarding hatchery practices and their effects on ESA-listed salmonids. Because most of the salmon harvested in California is believed to be derived from hatchery stocks, reductions in hatchery production are likely to have significant effects on fisheries. To help evaluate the economic effects of changes in hatchery practices, plans are underway to conduct an economic survey of salmon/steelhead freshwater anglers in California. In preparation for this survey, the Team has: (1) obtained the cooperation of CDFG's Inland Fisheries Division (as well as permission from CDFG attorneys to obtain access to steelhead report card data); (2) been working on a sampling protocol and questionnaire for submission to OMB; and (3) been in contact with United Anglers to obtain their support for the survey, and is moving forward with a cooperative agreement with PSMFC to conduct the survey.

### **Economic Activities in Support of Fishery Management**

The Economics Team is involved in a number of projects (funded by F/ST1) involving collection of economic data or enhancement of existing fishery databases. The intent of these projects is to provide information that can be used to evaluate the economic effects of management regulations such as harvest, season and area restrictions (including marine reserves). The Team's database development efforts include a number of completed, ongoing and planned projects as follows:

- *Economic survey of party/charter boat operators (completed)* – The Team played a significant role in the design and monitoring of an economic survey of west coast party/charter boat operators. The survey was conducted under a cooperative agreement with the PSMFC as a two-phase project. Phase 1, involving one-time interviews of vessel owners to collect annual revenue and cost data, was completed last year. Phase 2, which involved collection of trip-level revenues and costs over a 12 month sampling period, was completed

in June 2002. The Team is now collaborating with the PSMFC on a report that will summarize survey results.

- *Project to enhance PacFIN Research Database (RDB) with vessel permit data* – The Team is collaborating with the PSMFC on a project to supplement the PacFIN RDB with information on the types of federal and state permits held by individual vessels. If successful, this project will allow fishery managers to more accurately identify the fishery options available to individual vessels and thus better pinpoint where displaced effort is likely to go when regulatory restrictions are imposed on a fishery. This project is being undertaken as a function of the PacFIN Committee.
- *Project to evaluate utility of area-of-catch data collected in Marine Recreational Fishery Statistics Survey* – Several years ago the RecFIN Committee agreed to add a question to the MRFSS Intercept Survey regarding area-of-catch. The intent of this question was to facilitate the ability of fishery managers to evaluate the effects of area-based fishery restrictions on recreational anglers. The Team is working with the PSMFC to evaluate the area-of-catch data collected thus far in terms of (1) how the data compare with area-of-catch data from other data sources, and (2) whether the format of the MRFSS question and the MRFSS sample sizes on area-of-catch provide useful information for management. The Team intends to follow up this evaluation with recommendations to the RecFIN Committee regarding ways to improve the area-of-catch data.
- *Economic survey of commercial hook-and-line vessels* – The Team is collaborating with the NWR and the PSMFC on an economic survey of commercial groundfish and salmon vessels that use hook-and-line gear. In preparation for the survey, the Team provided the PSMFC with information regarding sample size requirements for the survey and also participated in an economic data collection workshop at which a number of data collection strategies were discussed and critiqued. The workshop was attended by NMFS and Council economists, industry representatives, university researchers and Sea Grant advisors. Industry participation was particularly valuable in terms of the advice they provided regarding how to best obtain industry cooperation for economic surveys. Survey implementation will begin once OMB approval is obtained.

One of the most difficult aspects of regulatory analysis is predicting the response of fishermen to regulatory changes. The Economics Team is involved in several projects to model commercial and recreational fishing behavior, as follows:

- *Economic modeling of entry/exit decisions in commercial fisheries* – The Team has developed a “real options” modeling framework that provides insights into the effects of catch expectations and ex-vessel prices on decisions by vessel operators to enter or exit the salmon fishery. A manuscript describing the basic model and results is in preparation, and extensions of the basic model (e.g., explicit representation of the fish stock, application to vessel or permit buyback programs) are being explored. The model is being tested with salmon data but has broad applicability to other fisheries. The model is particularly relevant

to addressing issues related to capacity reduction in the groundfish fishery - a high priority management need.

- *Economic modeling of angler behavior* – The Team is providing 18 months (January 2002-June 2003) of support under JIMO for a postdoc to estimate a model that (1) predicts discrete choices regarding fishing mode, fishing location and target species made by marine anglers and (2) provides mode-, location- and species-specific estimates of economic value for the fishery. The model is being estimated with angler survey data collected in 1998.

### **Other Team Activities**

- *Educational, planning and administrative activities* - The Team participates in workshops and meetings that enhance the Team's ability to conduct data collections and research and to stay current on technical issues related to fishery management. For instance, the Team participated in a Sea Grant workshop to identify socioeconomic studies needed to address marine management issues (Watsonville, February 2002), an Economic Data Collection Workshop (Portland, April 2002), and a Recreational In-Season Quota Monitoring Workshop (San Diego, June 2002). The Team actively solicits funding from ST1 for recreational fishery projects, coordinates with other SWR/SWFSC economists on allocation of funding for commercial fishery data collections, and works with Santa Cruz Lab administrative staff to administer the funding received. To help alleviate the problem of limited resources to do analytical work, the Team hired a postdoc, with limited success. To help meet future analytical needs, the Team is considering other options, e.g., providing support and guidance to UCSC graduate students who may not be familiar with economic models but have the quantitative skills to learn such modeling approaches.

### **Publications**

- Finalized *Proceedings of Salmon Habitat Restoration Cost Workshop* - a collaborative effort with PSMFC.
- Authored a paper for the *Proceedings of the Salmon Habitat Restoration Cost Workshop* that summarizes workshop conclusions and recommendations.
- Authored a paper on "The Allocation Problem in Habitat Restoration" for the *Proceedings of the Salmon Habitat Restoration Cost Workshop*.
- Authored chapter on "The Human Ecosystem" in CDFG publication *California's Living Marine Resources: A Status Report*.

### **Presentations**

- Participation in a Conference on Benefits and Costs in Natural Resource Planning (Monterey, February 2002).
- Presentation on "Quantitative Management Models for Forests and Fish" at a symposium on research being done at Jackson State Forest (Fort Bragg, May 2002).
- Poster on "Quantitative Methods for Habitat Restoration Planning" at the American Fisheries Society California-Nevada Chapter meeting (Lake Tahoe, April 2002).

**Committees**

- PFMC's SSC - responsibilities include presentations to the PFMC and occasional interactions with the California Fish and Game Commission.
- Chair, SSC Marine Reserve Subcommittee.
- SWFSC representative on the RecFIN Committee. RecFIN responsibilities involve communication and coordination with PSMFC, ST1, other NMFS west coast offices and state fishery agencies on resolution of recreational fishery data collection issues.

**Program Development**

- Completed phase 2 of cost-earnings survey of west coast party/charter boat operators.
- Worked with PSMFC on significant expansion of California Habitat Restoration Project Database to include all projects administered by CDFG Fishery Restoration Grants Program, National Fish and Wildlife Foundation and Coastal Conservancy.
- Completed update of ESA small business database.

## **Groundfish Analysis Team**

### **Introduction**

The Santa Cruz Laboratory has supported essential needs of the NMFS and PFMC for information on groundfish for 25 years. Laboratory scientists have been members of the PFMC's Groundfish Management Team (GMT) every year since its inception in 1977, and have made many significant contributions in the form of stock assessments, development of new methods, evaluation of alternative management procedures, and collection and processing of important data on fisheries and resources. In view of the deteriorated condition of groundfish stocks along the U.S. west coast, the need for technical information on groundfish is critical, especially for the California component of the fishery.

### **Objectives**

The goal of the Santa Cruz Laboratory's groundfish research programs is to support the information needs of the PFMC regarding Pacific coast groundfish stocks. Specific objectives are as follows:

- **Resource Information:** Collect and develop information that is useful in assessing and managing groundfish stocks, including both fishery-dependent and fishery-independent information (e.g., resource surveys), ecological and oceanographic studies.
- **Resource Assessment and Policy Analysis:** Conduct stock assessments that provide an understanding of the status and dynamics of groundfish stocks as a basis for harvest management decisions, and evaluate alternative harvest policies that have the potential to improve management performance.
- **Dissemination:** Disseminate information, research findings and associated advice to the fishery management community, including appropriate fishery management agencies, to the scientific community, and to the interested public.
- **Service:** Provide professional services (many of which fall in the above categories) at all levels, from Santa Cruz Laboratory support to participation in inter-agency, national and international working groups.

## Direct Council Support

### *Recent Groundfish Stock Assessments and Rebuilding Plans*

<u>Stock Assessments:</u>		<u>Rebuilding Analyses:</u>	
Chilipepper	1998	Bocaccio	2000, 2002
Bocaccio	1999, 2002	Pacific Ocean Perch	2000
Lingcod (south)	1999	Widow rockfish	2001, 2002
Canary (south)	1999		
Widow rockfish	2000	<u>ESA Biological Review:</u>	
Black rockfish	2001 (withdrawn)	Bocaccio	2002

Widow, bocaccio, black rockfish assessments planned 2003

Widow and bocaccio rebuilding analyses planned 2003

In 2002, bocaccio was assessed for the first time since the rebuilding plan was initiated in 2000. The previous assessment used data mostly from central California, but the new assessment includes data from southern California and better reflects the full range of the stock. Estimated productivity of the stock is lower in the new assessment, and relatively large catches in 2000-2002 resulted in a rebuilding Optimum Yield (OY) of zero. This poses a unprecedented problem for fishery management, and we provided the PFMC with various supplementary “Sustainability Analyses” to address the problem. Bocaccio will be re-assessed next year, allowing reconsideration of some aspects of the stock assessment (e.g., the natural mortality rate), and also allowing consideration of more recent data on the important 1999 year class. Black and widow rockfish assessments will also be conducted.

Development of a new Bayesian assessment methodology for relatively data-poor stocks was originally planned for 2002, but service on the GMT and addressing bocaccio issues required all available time. This is a more ambitious project that was previously thought.

*Groundfish Harvest Rates* – The papers from the comprehensive review of groundfish harvest rates (Seattle, March 2000) were published as a “module” in the North American Journal of Fisheries Management. Steve Ralston served as editor of the volume. Two of the papers in this module are authored by the Groundfish Analysis Team.

*Other Direct Council Support* – Alec MacCall continued to serve as the SWFSC member of the PFMC's GMT, and will be replaced by Xi He in 2003. Steve Ralston has been serving on the PFMC's Scientific and Statistical Committee since 1999, and is chairman of its Groundfish Subcommittee. Ralston participated in two STAR Panel stock assessment peer reviews in 2003.

*Southwest Region Support* – In response to an ESA listing petition, a Biological Review of bocaccio was provided to the SWR. This will be the basis of a formal Biological Opinion. The response to the listing petition is behind schedule, mainly due to a delay in preparing the Biological Review so that it could benefit from the most recent stock assessment.

## Indirect Support for Groundfish Management

*Database Management* – Don Pearson has worked closely with the California Department of Fish and Game (CDFG) to coordinate port sampling efforts and to maintain the CALCOM database, which serves as the source of the data feeds provided to PacFIN by the State of California. The system provides port sampling biologists with Internet access to the database, so that monitoring data is entered directly in real time. The database was attacked by hackers on numerous occasions, leading to a complete revision of both hardware and software, an effort that is ongoing.

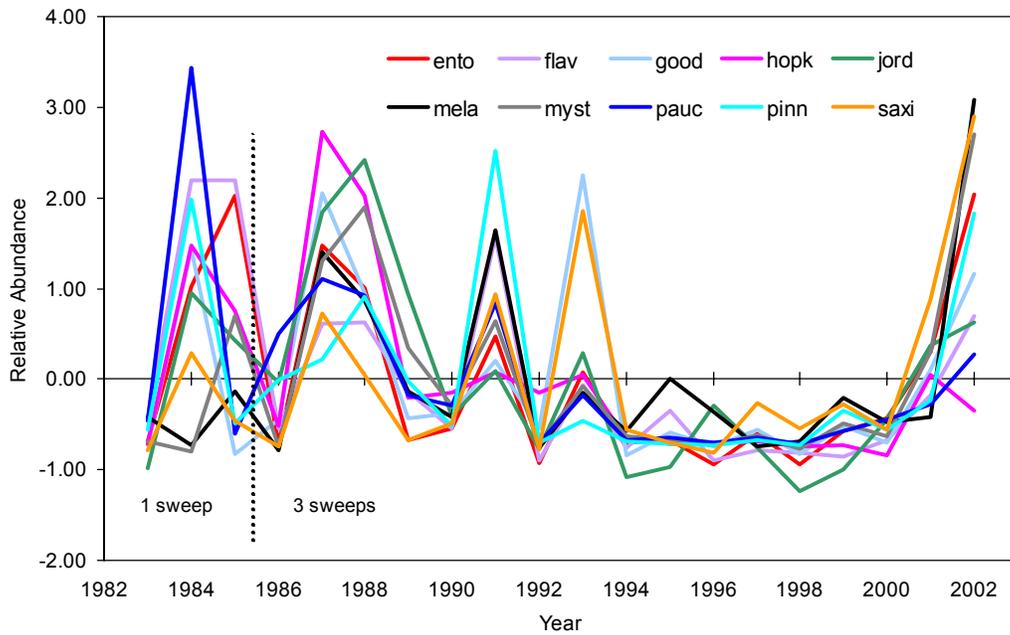
## Surveys and Ecological Research

The Groundfish Analysis Team has considerable experience in performing fishery-independent sea-surveys. Data collected from these cruises have been useful in the assessment and management of west coast groundfish.

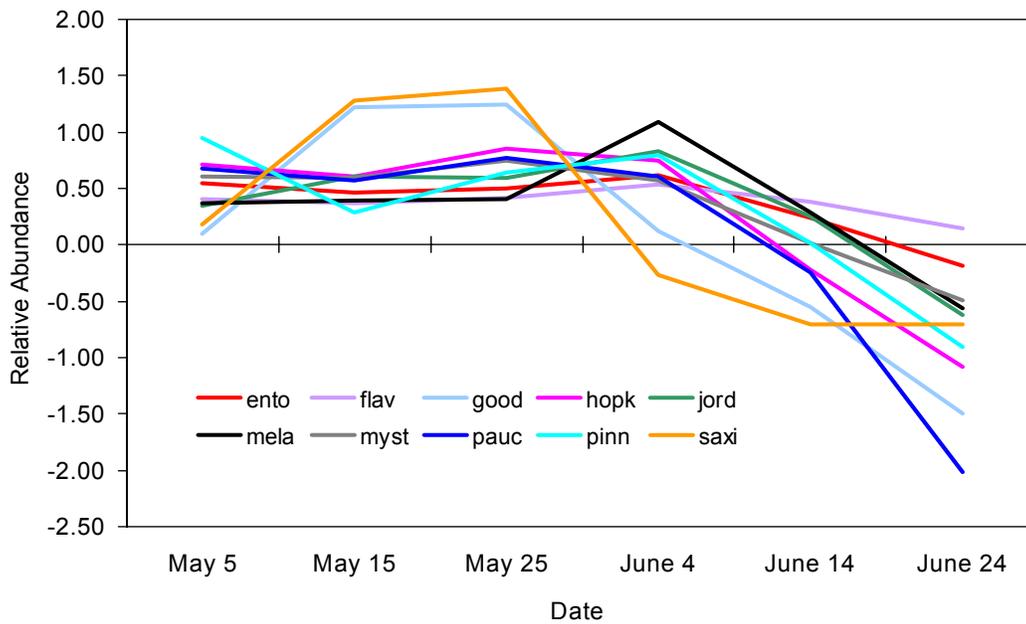
*Rockfish Recruitment Survey* – Rockfish of the genus *Sebastes* exhibit extreme variability in reproductive success, and the productivity of rockfish fisheries depends almost exclusively on the occurrence and influx of strong year-classes. Management of these fisheries therefore benefits from accurate information on impending recruitment. To meet that need, the Groundfish Analysis Team has used the NOAA vessel *David Starr Jordan* to conduct an annual survey of the distribution and abundance of pelagic juvenile rockfishes since 1983. The goal of the survey is to provide an information base for forecasting future recruitment to rockfish and other groundfish stocks. Because rockfishes recruit at ages 2-6 years old, these surveys provide a fairly long-term forecast of significant fluctuations in recruitment. Many west coast groundfish stock assessments (black rockfish, bocaccio, chilipepper, widow rockfish and Pacific whiting) use our pelagic juvenile index to estimate recruitment strength of existing year classes that are not yet old enough to appear in fishery catches, greatly improving the accuracy of forecasts. Juvenile abundances were remarkably high for many (but not all) species in 2002 (Figure 1), giving the clearest indication yet that the prolonged recruitment failures of the 1990s are now over.

The statistical calculation of juvenile abundance indexes is being revised. The indexes formerly were based on stratified means from the “sweep” with highest abundance. We are now using a generalized linear model incorporating a delta-lognormal distribution, with year effects (the abundance index), station effects and calendar date effects. Explicit consideration of calendar date has allowed a better description of the “time window” during which these cruises must be conducted, particularly with respect to the settlement of the juvenile rockfish out of the pelagic environment in mid-June (Figure 2).

*Rockfish Larval Production Survey* – A manuscript describing a larval production method estimate of shortbelly rockfish abundance (by Ralston, Bence, Eldridge and Lenarz) was accepted for publication in *Fishery Bulletin*. Samples of chilipepper rockfish taken aboard the NOAA ship *MacArthur* in January, 2000, were sorted, and subsamples were sent to Russ Vetter, SWFSC, Coastal Fisheries Division, for genetic identification. We are exploring a possible collaboration



**Figure 1.** Annual recruitment estimates (log scale, standardized) from the pelagic juvenile rockfish midwater trawl survey. Poor conditions during the 1990's appear to have abated for most, but not all species.



**Figure 2.** Seasonal patterns in the availability (log scale) of pelagic juvenile rockfish to the midwater trawl survey. Catch rates begin to fall precipitously by mid-June.

with La Jolla's Coastal Fishery Division in developing a larval production estimate of bocaccio abundance in southern California.

*Central California Cooperative Groundfish Ecology Survey* – In an effort to obtain a more comprehensive understanding of the central California groundfish community and groundfish ecology, Don Pearson designed and initiated an intensive local groundfish survey beginning in late 2001. We subsequently were awarded Cooperative Research Funds to expand the survey to full annual coverage. The survey utilizes chartered commercial trawl and longline vessels using standardized gear, and operating over a range of depths in an area off Davenport, near the Santa Cruz Laboratory. During this first year, an inshore-offshore suite of stations was occupied monthly to obtain detailed information on annual cycles including species location and co-occurrence, maturation, and otolith edge formation. In the future, the frequency of surveys at this location will be reduced to a smaller number of months that are adequate to sample the important patterns of variability, and new stations will be sampled to improve our understanding of groundfish habitat and ecology. This project supports several small collaborative life-history research projects with Moss Landing Marine Laboratory, including the newly established NOAA Cooperative Center for Shark Research at Moss Landing Marine Laboratory.

Some highlights of the Groundfish Ecology Survey are:

- Funding for cooperative research was obtained.
- Logistics, methods and protocols for cooperative research aboard commercial fishing vessels were developed.
- Extensive samples allowing estimation of age, growth, maturity and fecundity for several species, particularly those that are too small to be landed commercially, or occur too deep to be landed recreationally, have been collected. Some of these species, such as the stripetail rockfish (*S. saxicola*) are showing disproportionate increases in abundance (Figure 1), and may be ecologically replacing depleted species of larger rockfish.
- A potentially serious problem was identified, wherein blackgill rockfish can easily be mistaken as darkblotched rockfish (an overfished stock) in fishery samples. Otoliths of the two species appear to be distinguishable, allowing a historical review of the misidentification rate. The extent of the problem is under investigation by Santa Cruz Laboratory and by the NWFSC.
- Annual otolith ring formation in olive rockfish has been validated.
- Tagging of nearshore groundfish species has been initiated.
- Hook-timers have been developed to investigate and resolve problems with gear saturation.
- Elasmobranchs have been provided to NOAA Cooperative Center for Shark Research at Moss Landing Marine Laboratory.
- Grenadiers have been provided to the Monterey Bay Aquarium Research Institute.
- This program has also provided public relations benefits to NMFS and the Santa Cruz Laboratory through improved credibility with the local fishing community – a common complaint is that the fishery scientists do not spend enough time “on the water.”

## **Publications**

- Ralston, S., J. R. Bence, M. B. Eldridge, and W. H. Lenarz. In press. An approach to estimating rockfish biomass based on larval production with application to *Sebastes jordani*. *Fishery Bulletin*.
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- Ralston, S. 2002. West coast groundfish harvest policy. *North American Journal of Fisheries Management* 22(1):249-250.
- Sakuma, K. M., F. B. Schwing, M. H. Pickett, D. Roberts, and S. Ralston. 2002. The physical oceanography off the central California coast during May-June, 2000: a summary of CTD data from pelagic juvenile rockfish surveys. NOAA Technical Memorandum NMFS-SWFSC-318. 83 p.
- Williams, E. H. 2002. The effects of unaccounted discards and misspecified natural mortality on harvest policies based on estimates of spawners per recruit. *North American Journal of Fisheries Management* 22(1):311-325.

## **Presentations**

- NMFS Stock Assessment Workshop, Santa Cruz, CA (MacCall)
- CalCOFI, La Jolla, CA (Ralston)
- Testimony to California Fish and Game Commission, various, (Ralston)
- Panel Discussion of MPA science, Pajaro Dunes, CA (Ralston)
- Climate and Fisheries Workshop, Honolulu, HI (MacCall)

## **Committees and Service**

- Hosted NMFS Stock Assessment Workshop (MacCall)
- NMFS Bocaccio Biological Review Team (MacCall and He)
- NMFS Committee to Estimate Fishing Capacity (MacCall)

- NMFS Trawl Standardization Workshop (Sakuma)
- PFMC Scientific and Statistical Committee (Ralston)
- PFMC SSC Review of Channel Islands MPA (Ralston)
- PFMC Groundfish Management Team (MacCall)
- NMFS representation at PFMC public hearings (Ralston)
- Participation on STAR peer-review panels (Ralston)
- CSTAR Program development (MacCall)
- CSTAR Doctoral committees (MacCall, Ralston)
- Editor, North American Journal of Fisheries Management (Ralston)
- Editor, Ecological Applications (MacCall)
- Advice to California's Nearshore Species Plan Development Team (MacCall)
- Review of California's White Seabass Fishery Management Plan (MacCall)

## ECOLOGY BRANCH

The Ecology Branch conducts basic and applied research to increase understanding of the relationships between fishes and their environment, including distribution and abundance patterns, factors influencing growth and survival, habitat relationships, and community structure. This information is provided to fishery managers and the public via direct communication, reports, presentations, and peer-reviewed scientific publications. The Branch is comprised of three components. The Salmon Ecology and Genetics Team focuses on studies that address biological development and genetic relationships of salmonids at the southern margin of their distribution and the influences of estuarine and marine conditions on interannual variability of stock status. The Habitat Ecology Team identifies and describes essential fish habitat for groundfish species; in particular, those that are managed and overfished and conducts research in cooperation with NOAA MPA Science Institute on siting, evaluation and implementation of MPAs in California. The Early Life History Team conducts field and laboratory experimental research examining factors that affect survival in larval and early juvenile stages of salmonids and groundfish.

### Salmon Ecology & Genetics Team

#### Introduction

Salmonid stocks (chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *Oncorhynchus kisutch*, and steelhead, *Oncorhynchus mykiss*) from California's Central Valley and coastal streams continue to decline. All four of California's Central Valley chinook runs are either listed or candidates for listing ESA. Coastal chinook, coho, and steelhead ESUs are similarly imperiled. Although freshwater habitat loss and degradation contribute to population declines, estuarine and ocean conditions apparently play a major role in the interannual variability in salmon abundance, especially during the first months after exiting freshwater. Climatic and oceanographic forcing factors, affecting scales ranging from seasonal localized habitats to interdecadal ocean-basins, modulate environmental conditions that, in turn, affect marine productivity. Productivity and the physical environment influence salmon growth, development, and survival.

Effective management of California salmonid stocks and their ecosystems requires greater knowledge of the ecology and genetics of salmonids. The need for greater knowledge of growth, development, survival, and the environmental variables that are beneficial or detrimental to these processes is particularly critical for early life stages during their residence in estuaries and in the first year of ocean life, when mortality rates can be quite high. The need for basic biological data and the influences of environmental factors on survival and health have been identified as high priority research needs by the PFMC (Research and Data Needs 1998-2000, PFMC, September 1998) as well as the scientific community (Estuarine and Ocean Survival of Northeastern Pacific Salmon, Proceedings of the Workshop, April 1997; NMFS Estuarine and Ocean Salmon Strategic Research Plan, April 1998). Implicit in understanding salmon-environmental relationships and their application to salmon management is the ability to distinguish separate populations, including those of natural and hatchery origins, by determining relationships among

source populations and within metapopulations using both biomechanical genetic and otolith microchemistry and microstructure based techniques. The research projects conducted by the Salmon Ecology and Genetics Team improve understanding of salmon environmental requirements and associations among stocks and with their environment. This information will assist focusing conservation, recovery, and management efforts on the most cost-effective options for this socio-economically valuable resource.

## **Objectives**

- **Estuarine and Ocean Ecology:** Determine juvenile salmon abundance, distribution, growth, energy status, physiological development, trophodynamics, natal origin, contribution to ocean fisheries, and the influences of environmental factors.
- **Population Genetics:** (1) provide comprehensive assessment of genetic population structure for California salmonids; (2) establish a repository of salmonid genetic material for use by NMFS and other researchers; (3) develop new methods for the analysis of population genetic data and apply them to protected species; (4) use biochemical genetic methods to conserve genetic resources in California coho salmon; and (5) develop new genetic tools to estimate trophic interactions between salmonids and marine mammals.
- **Comparative Studies on Hatchery and Wild Salmonids:** Determine differences in early life history and the types, extent, and consequences of interactions between naturally-spawned and hatchery-produced steelhead.
- **Coho Salmon Captive Broodstock:** Establish and maintain captive coho salmon from Scott Creek to aid in the persistence and recovery of the population at the southern margin of the species' distribution.

## **Estuarine and Ocean Ecology**

We survey and collect salmonids in estuaries and along the central California coast by surface trawl during outmigration and early ocean residence. Sampling sites are within the estuarine migratory corridor and in the coastal ocean along a series of transects from Pt. Arena to Pt. San Pedro between 15 and 50 fathoms depth, and in association with oceanographic features (fronts, upwelling centers, jets, eddies). Growth history is determined using otolith analysis, and sex, length, weight, physiologic condition (morphometrics; Na<sup>+</sup>, K<sup>+</sup>-ATPase), and energetic status (lipid class and protein analyses), are assessed. Species-specific and size-stratified stomach contents (quantity, prey species composition and dominance) are determined, .Assess forage fish and fish community coincident with juvenile salmonids (identify and enumerate species captured during salmonid collections).

We establish stock/run identity of individuals using genetics, otolith microchemical and microstructural analysis , and tagging/fin clipping. Migration and movement are determined using archival tags. Primary productivity is determined using calibrated vertical and horizontal

fluorometry and remotely via CCS satellite imagery, and secondary production (zooplankton and neuston abundance and species composition) is also estimated. We obtain environmental data (CTD data - depth profiles of temperature, salinity, PAR; current profiles; estuary closure) concurrent with salmon surveys. We obtain environmental data (e.g., current profiles, freshwater outflow, temperature, salinity, upwelling indices, sea level data, AVHRR and CZCS image data, barometric pressure, rainfall, wind) associated with field collections from other governmental and academic sources and integrate salmonid data with biotic and abiotic environmental data to determine variables affecting salmonid ecology.

## Population Genetics

- *Assessment of genetic population structure* – In support of the ESA TRTs, and in collaboration with the Fisheries Branch, we have undertaken a large-scale evaluation of genetic population structure for steelhead trout populations in California coastal ESUs. This study involves the collection of biochemical genetic data from samples of 50 individuals from 40 watersheds and 61 individual sites in the Northern California, North-central California, South-central California and Southern California ESUs. Approximately 6000 samples were collected from steelhead trout by field crews from the Santa Cruz Laboratory and collaborators. A standardized set of 18 microsatellite genetic markers has been developed and data has been collected for 12 of the markers for all 61 geographic localities. Future efforts will include collection of data from the remaining six microsatellite markers and sequences from two immunogenetic regions (MHC loci). The data are being used to estimate genetic distances and construct trees of population relatedness. Rates of migration and determination of change in effective population size have also been estimated. We have also begun a parallel effort for coho salmon, but a lack of tissue samples is currently limiting this effort.
- *Salmonid genetic repository* – The California Salmonid Genetic Repository at the Santa Cruz Laboratory has continued to receive samples. The Repository is a centralized, non-proprietary resource for genetic analysis of salmonids in California. It catalogs and provides long-term storage for genetic material extracted from tissue samples resulting from collecting activities by permitted agencies and individuals throughout California. Requests for purified DNA are granted to researchers who are competent in genetic analysis. The Repository will be an important resource for the scientific and management communities involved in salmonid issues in California. To date, the Repository has received samples from more than 8000 individual fish and currently holds extracted DNA from approximately 6000 steelhead, 1000 chinook and 1200 coho salmon.
- *Development and application of new analytical methods* – Because of the difference between census and effective population sizes in vertebrates, reductions in effective population size can be hard to detect. To remedy this problem, novel genetic methods for detecting reductions in effective population size have been developed. These methods have been applied to numerous salmonid datasets collected from the literature to identify populations potentially at risk due to genetic effects. Recent accomplishments include the development of a Bayesian version of our previously published ratio-based method, the assessment of the effects of

migration and mutation on the performance of these methods, and a new method to estimate the percentage of genetic variation lost due to reduction in population size.

- *Genetic evaluation of broodstock for hatchery and captive breeding of coho salmon* – Molecular genetic markers are being used to evaluate coho salmon collected as potential broodstock for hatchery and captive breeding programs in Scott Creek and the Russian River. Markers are used to develop breeding matrices that minimize inbreeding and outbreeding and maximize the conservation of genetic resources for the California Coast Coho Salmon ESU. Efforts in Scott Creek for the 2001/2002 broodyear resulted in a breeding matrix that reduced inbreeding by at least 20%.
- *Genetics in the study of salmonid/pinniped interactions* – The impacts of pinnipeds on salmonid populations are hard to measure. Observational methods and analysis of scat for salmonid hard parts both suffer from inherent biases and cannot often identify an individual fish to species or ESU. To overcome these limitations, we are developing a novel set of molecular genetic methods for the analysis of trophic interactions. These methods will allow a qualitative (i.e., identification to species or ESU) and quantitative (i.e., enumeration of individuals) assessment of pinniped impacts on protected and important fishery species. A UCSC doctoral student (Garza, co-advisor) working in the Santa Cruz Laboratory will work to implement these methods in the estimation of the impact of sea lions on salmonid populations in the Monterey Bay region. These data will help to assess and evaluate different proposed management strategies for pinniped/fishery interactions.

### **Comparative Studies on Hatchery and Wild Salmonids**

This study is conducted on steelhead trout in Scott Creek, Santa Cruz County. There is a hatchery on Big Creek, a tributary of Scott Creek, that fin clips all their hatchery-produced steelhead, allowing discrimination between hatchery and naturally-produced fish.

Juvenile steelhead are captured by trapping and seine at locations spanning the watershed. Occurrence at sequential sampling sites allows an assessment of emigration timing, distribution, growth, and smolt condition. Once captured, the following data are collected: origin (hatchery, natural), size, and condition factor ( $K$ ). A small piece of fin tissue is preserved for subsequent DNA analyses (to determine local gene flow, inbreeding/ outbreeding depression). To assess the degree of smoltification and the ability to enter the ocean, a small piece of gill filament will be excised for  $\text{Na}^+, \text{K}^+$ -ATPase analysis. Juveniles are returned to the stream following sampling. Data will be analyzed to determine differences between hatchery and wild juveniles and the extent and consequences of their interactions. To determine run timing, stream distribution, and individual characteristics, adults are caught by seine and sex, origin, length, and weight are recorded. Before release, a multicolored Floy<sup>®</sup> tag is inserted just below the dorsal fin to allow monitoring of hatchery and natural-run spatio-temporal distribution and movement. Fin tissue samples will be subjected to DNA analysis. Spawning behavior is observed and recorded by digital video recorder in a short segment of Scott Creek where most of the spawning occurs. Data are recorded on the number of spawners, and the number, type (hatchery or wild steelhead; resident rainbow trout) and dominance of males involved. Reproductive success data will be collected on individuals and will include measures of aggression, cuckolding rates and the

occurrence of spawning behaviors. In addition, substrate composition, redd size, and redd location as well as water quality measurements (e.g., temperature, dissolved oxygen and flow rate) will be taken to describe redd quality. Data will be analyzed to determine the extent and relative reproductive success of hatchery-wild interbreeding.

### **Coho Salmon Captive Broodstock**

We are constructing a captive broodstock seawater holding facility at the NMFS Santa Cruz Laboratory and satellite freshwater facility at Big Creek Hatchery. Captive broodstock will be acquired as juveniles from Big Creek Hatchery. Juveniles will be progeny of adults trapped from Scott Creek and spawned at the hatchery. Two separate year-classes will be maintained to provide 100 mature adult southern coho salmon each. All fish will be PIT tagged for identification. We will use genetic analysis to maintain and perhaps increase the genetic diversity of broodstock for use as ripe adults to Big Creek Hatchery for spawning. Gametes from captive coho salmon will only be used as last resort; when available, gametes from returning fish will be used to maximize fitness of spawners. If excess adults are available, they may be placed in suitable streams under guidance of NMFS Salmon Recovery Team for Central California ESU. We will perform field and laboratory experiments on a subset of the captive broodstock and their progeny to increase knowledge and understanding of physiological and ecological requirements and adaptations of southern coho salmon to improve effectiveness of recovery actions. At present we intend to evaluate the success of program annually, and when naturally-produced southern coho salmon stocks in Scott Creek are self-sustaining, or after three generations of three captive brood years (whichever occurs first) we will discontinue the program.

### **Publications**

- Norton, E.C., R.B. MacFarlane, and M.S. Mohr. 2001. Lipid class dynamics during development in early life stages of shortbelly rockfish and their application to condition assessment. *J. Fish. Biol.*: 1010-1024. (From previous, non-salmonid research)
- MacFarlane, R.B., and E.C. Norton. 2002. Physiological ecology of juvenile chinook salmon (*Oncorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and the Gulf of the Farallones, California. *Fish. Bull.* 100:244-257.
- Wlasiuk, G., J.C. Garza, and E. Lessa. 2002. Genetic and geographic differentiation in the Rio Negro tuco-tuco (*Ctenomys rionegrensis*). *Evolution*. (In press) (From previous, non-salmonid research)
- Eldridge, M.B., E.C. Norton, B.M. Jarvis, and R.B. MacFarlane. Dynamics of early development in the viviparous yellowtail rockfish. *J. Fish. Biol.* (In press) (From previous, non-salmonid research)
- MacFarlane, R.B., S. Ralston, C. Royer, and E.C. Norton. Influences of the 1997-1998 El Niño and 1999 La Niña on juvenile chinook salmon in the Gulf of the Farallones. PICES Scientific Report. (In press)

## **Presentations**

- PICES 10<sup>th</sup> Annual Meeting, Victoria, B.C., Canada (MacFarlane, Ralston, Royer, & Norton)
- State of the Estuary Conference, San Francisco, CA (Norton & MacFarlane)
- Salmon Ocean Ecology 4<sup>th</sup> Annual Meeting, Santa Cruz, CA (MacFarlane, Ralston, Norton, & Royer)
- Salmon Ocean Ecology 4<sup>th</sup> Annual Meeting, Santa Cruz, CA (Johnson, Grimes, & Royer)
- Salmon Ocean Ecology 4<sup>th</sup> Annual Meeting, Santa Cruz, CA (Norton)
- Salmon Ocean Ecology 4<sup>th</sup> Annual Meeting, Santa Cruz, CA (Norton & MacFarlane)
- Larval Fish Conference, 26<sup>th</sup> Annual Meeting, Bergen, Norway (MacFarlane & Norton)
- Larval Fish Conference, 26<sup>th</sup> Annual Meeting, Bergen, Norway (Grimes, Johnson & Donohoe)
- FishNet 4C Conference, San Francisco, CA (Garza)
- AFS CalNeva 36<sup>th</sup> Annual Meeting, Tahoe City, CA (Garza)
- Coastwide Salmon Genetics Meeting, Bodega Marine Laboratory, Bodega Bay, CA (Garza, 2 presentations)
- Public outreach meeting for NOAA, CDFG, & NPS to present restoration plan for coho salmon in Marin and Sonoma Counties, Pt. Reyes, CA (Garza)

## **Committees and Service**

- Southwest Region Equal Employment Opportunity Advisory Committee—Chair of the Personnel Subcommittee (Norton, to Jan 2002)
- Southwest Region Equal Employment Opportunity Advisory Committee (Garza)
- Salmonid ESA Technical Recovery Team for North-central California Coast (Garza)
- Russian River Coho Salmon Recovery Work Group (Garza)

## **Program Development**

- Funding: Comprehensive Assessment of Genetic Population Structure and Diversity of Central Valley Chinook Salmon, CalFed Bay Delta Program (Garza, \$385K for 3years)
- Initiated comparative studies of hatchery and wild steelhead in Scott Creek. Data have been collected for spawning adults from the 2001-2002 year class and their progeny.

## **Future Directions**

- *Ocean Ecology* – We will continue the multiyear study of the ocean ecology of juvenile salmonids. We will survey and collect juvenile salmon, plankton, and oceanographic data on the central and northern California coast to gain better understanding of the interannual variability of ecological and physiological processes and the influences of ocean conditions and features (e.g., eddies, jets, upwelling centers, estuarine plumes, etc.). Since October 2001, the study area is from Pt. San Pedro northward to Ft. Ross. In addition to Central Valley chinook salmon and steelhead, this region includes ocean entry points for juvenile salmonids exiting the Russian River and several productive coho salmon and steelhead coastal streams. The potential to gain greater understanding of the influences of biotic and abiotic oceanographic variables on salmon may be increased by collaboration with a study of coastal wind-driven ecosystem dynamics conducted by scientists from Bodega Marine Laboratory, Scripps Institution of Oceanography, and other academic institutions. Their study area extends from Pt. Reyes to north of the Russian River.

- *Estuarine Ecology* – Presently, the San Francisco Estuary and five small estuaries are being studied. Juvenile salmon, plankton, and hydrologic data are collected and analyzed from the entrance and exit of San Francisco Estuary. We will continue monitoring juvenile chinook salmon dynamics in this large urban estuary to improve our understanding of long-term interannual variability in growth, energy status, and physiological development, and its causes. The San Francisco Estuary study and the small estuary study will be modified and expanded by the addition of Dr. Ellen Freund. For the past three years, the small estuaries study has been limited to snorkel surveys of temporal patterns of juvenile salmonid abundance, water quality measurements, and sandbar status conducted by Tom Laidig and members of the Salmon Ecology Team. With the addition of Dr. Freund the study will be expanded and likely include assessments of metabolic and cardiac performance.
- *Population Genetics* – The study of genetic population structure will be extended to provide a comprehensive assessment of Central Valley chinook and coastal coho salmon stocks. With the addition of a Research Geneticist, currently being recruited, biochemical genetic methods will be employed to study trophic interactions of juvenile salmonids during estuarine residence, and to estimate reproductive success in steelhead populations in Scott and Big Creeks. Additionally, modern gene mapping methods will be used to identify genes contributing to the determination of life history strategy and reproductive success in steelhead populations in Scott and Big Creeks.
- *Comparative Studies on Hatchery and Wild Salmonids* – This coming year will be the second year of a two-year study funded through the California Coastal Salmonid Restoration Program (CCSRP) to determine life history traits and hatchery-wild interactions of steelhead in Scotts Creek. A proposal has been submitted to the CCSR to continue this work. The proposed study will assess patterns of outmigration, thermal characteristics of ocean residence, ocean growth, adult return rates and survival for wild and hatchery steelhead and coho salmon populations in Scott Creek.
- *Coho Salmon Captive Broodstock* – Construction of seawater and freshwater facilities to maintain broodstock of southern coho salmon will be completed by March 2003. The seawater captive broodstock facility will be at the Santa Cruz Laboratory and the freshwater component will be at the Big Creek Hatchery. Progeny from the 2001-2002 year class of returning adult coho salmon are being raised at Big Creek Hatchery. We will determine the genetic composition of a subset of juveniles and select a diverse cohort of 100 fish to be maintained in the seawater facility and 50 fish for the freshwater facility. The captive broodstock will be raised to maturity and provide gametes to supplement those from returning salmon during the winter of 2004 to Big Creek Hatchery. The process will be repeated yearly for three cycles of three year classes, or until sustained adult returns are established in Scott Creek, whichever occurs first. When coho salmon production exceeds that required to maintain the Scott Creek population, excess progeny will be utilized in experiments to determine physiological and ecological adaptations of the species at the southern margin of its distribution. Unused broodstock and progeny will be available for reintroduction into streams with restored habitat as well.

## **Groundfish Habitat Ecology Program**

### **Introduction**

The reauthorized Magnuson-Stevens Fishery Conservation and Management Act has created a mandate for the National Marine Fisheries Service to identify and describe essential fish habitat (EFH) for managed species, and to protect and restore (where necessary) these habitats. A second mandate of the Act, which has direct relevance to EFH, is to identify and rebuild those managed stocks that are overfished. Several groundfish species on the west coast have been designated as overfished; it is especially important to characterize and protect EFH of these species. However, the necessary EFH information is either non-existent or incomplete for most groundfish species.

The Santa Cruz Laboratory has developed a research program to effectively respond to the EFH mandate; our team recently has expanded from two to five research biologists. Several funding opportunities for marine groundfish habitat research both within NMFS and from other NOAA offices (Sea Grant, NURP, Ocean Exploration, NOS), USGS, state agencies, and private foundations have been successfully pursued in recent years.

### **Objectives**

- Characterize Deep-Water Benthic Habitats and Associated Groundfishes
- Develop New Technology to Map Seafloor Habitats
- Evaluate Subtidal Rockfish Recruitment and Associated Ocean Conditions
- Consider Marine Protected Areas to Conserve, Rebuild, and Manage Groundfish and Habitats
- Inform ocean policy, resource management, and public knowledge on marine fishery issues.

### **Deep-water Fish and Habitat Associations**

Classification of habitat attributes on scales pertinent to animal distributions and ecological problems in deepwater marine environments is difficult because of the restricted access to this system. Since 1992, we have been developing new tools, technologies, and partnerships to characterize deepwater fishes and habitats. Our application of geophysical techniques to map the seafloor and submersible observations to directly count fishes along randomly or systematically selected transects at predetermined dive locations has made fish-habitat surveys in deep water commonplace nationwide. We have applied this approach to de facto marine reserves, in and adjacent to the Big Creek Ecological Reserve of the Big Sur coast, and elsewhere along the central coast. Our research addresses goals to describe and conserve EFH, identify areas in need of additional protection, improve assessments of groundfish populations, and evaluate ecological

effects of fishing. Our approach is especially critical when focusing on benthic habitats of extreme heterogeneity and biological assemblages of high diversity.

In collaboration with researchers from the University of California Santa Barbara, Moss Landing Marine Labs, and CA Dept. Fish and Game and with funding from NMFS Offices of Protected Resources and Habitat Conservation, NOAA NURP, NOAA Center For MPA Science, and the David and Lucille Packard Foundation, we currently have initiated a monitoring protocol for fish, macroinvertebrates, habitats, and incidence of fishing gear and disturbance on offshore banks in and around the Cowcod Conservation Area off southern CA. Underwater surveys of groundfish populations and their habitats are conducted off southern California using non-extractive video-transect methodologies and direct observations from an occupied research submersible (*Delta*). Digital, georeferenced maps of the seafloor, acquired from side-scan sonar, multibeam bathymetry, seismic reflection and other past geophysical surveys and integrated into a GIS, are used to identify and select sites with appropriate habitats. Past and recent groundfish catch and effort records also are used to assist in locating appropriate survey sites. Evaluating the effectiveness of these new Marine Protected Areas depends on timely and accurate assessment of the ecological response of target species to increased protection. Without a rigorously determined baseline to support long-term assessments of fishes and associated habitats, the effectiveness of this MPA will remain uncertain and subject to doubt. Our staff also is working with biologists at Cordell Bank National Marine Sanctuary, to assist in developing survey methodologies that will result in an inventory of organisms and habitats of this deepwater offshore Bank and also allow for comparisons among fish habitats along the central coast.

With the addition of a post-doctoral fellow (Tara Anderson), our team is addressing the relationship between patterns in groundfish distribution and abundance and seafloor habitats at a range of spatial scales. Using observational data collected by the Habitat Ecology team from a manned submersible, we are examining the association of groundfish species with different types of habitat patches and addressing how the local scale (10's- 100's of meters) and large scale (km's) arrangement of these patches are important in structuring fish assemblages. The ability to link fine-scale biological information with large seafloor geological habitat maps and fishery activities will enable us to extrapolate relative to these habitats and is a central focus to this project. This post-doctoral fellowship position is funded jointly by NMFS-SCL and USGS-Coastal and Marine Geology, and has been particularly effective in establishing a stronger research connection between the two laboratories.

Our staff is assisting with the efforts of NMFS Office of Science and Technology in producing the first edition of *Our Living Oceans Habitat 2000*. This report will summarize the status and trends of habitats used by those living marine resources under NMFS purview. Our staff organized the Pacific Coast Region section of this document, and wrote the description of west coast groundfish habitat.

## **New Technologies**

One challenge is to efficiently relate small-scale observations and assessments of animal-habitat associations to the large geographic scales on which benthic fisheries operate. Laser Line Scan (LLS) is a recently developed underwater optical imaging technology that shows promise

for rapid, high-resolution habitat mapping. The LLS could bridge the gap between in situ observations and imaging with side scan sonar or multibeam acoustic systems.

With funding from NOAA NURP and Office of Ocean Exploration in FY02, we conducted a 9-day field test of laser line scan imaging technology (LLS) to characterize and explore benthic habitats in and around the Big Creek Ecological Reserve within the Monterey Bay National Marine Sanctuary off the central California coast. Our goal was to determine the use of LLS to assess the distribution and abundance of fish, megafaunal invertebrates, and seafloor habitats, and to compare LLS images with those acquired from side-scan sonar and a remotely operated vehicle. We surveyed an area about 2.6 km long and 0.4 km wide inside and directly outside the Reserve. With the laser we imaged isolated rock outcrops with patches of large sea anemones and dense groups of fishes, drift kelp, sea pens, salp chains, and sedentary benthic fishes (including California halibut, Pacific electric ray, ratfish, and juvenile lingcod). The LLS system offers the advantage of imaging some of the biogenic components of habitat and describing their spatial relationships with detail that currently is not possible using acoustic techniques such as side-scan and multibeam sonar (e.g., LLS can differentiate cm-size objects). The LLS system also did an excellent job imaging details of the low relief shelf sediments such as sand waves and ripples; evaluating these features in a broader context from a post-processed mosaic of the seafloor could help us understand coastal physical processes that influence dynamic benthic habitats. We also are developing capabilities to more efficiently post-process the immense quantity of digital imagery generated by LLS. Further development of LLS could improve our understanding of deep-water fish habitats.

### **Subtidal Recruitment and Ocean Conditions**

With the decrease in population size of many rockfish stocks, accurate forecasting of recruitment to the fishery is needed to adequately manage the stocks and set catch quotas. Since 1983, personnel from the Santa Cruz Laboratory have conducted nearshore juvenile rockfish recruitment surveys off the coast of northern California. Also, since the lab moved to Santa Cruz, a new sampling site has been established at the southern end of Monterey Bay for comparisons of recruitment and other life history aspects with that information collected to the north. For three rockfish species, we estimate the number of individuals that survive the pelagic phase and the recruitment strength each year. From these long time series we can better predict the year classes that potentially will contribute to the fishery in following years. By comparing these time series with similar results from elsewhere along the coast, we will develop a rockfish recruitment index, determine recruitment timing, and evaluate factors (i.e., environmental and biological) that may influence recruitment on local and coast-wide scales.

Our staff is coordinating with similar subtidal survey efforts coastwide in an effort to standardize protocols and methods and interpret results among all surveys. In June-July, 2002, our staff joined PISCO (Partnership of Interdisciplinary Studies of Coastal Oceans) to train divers in standard fish and invertebrate survey methodologies, and taught a segment of the course on juvenile rockfish identification. Data collected through this method will be analyzed to determine coastwide trends among nearshore fishes. Our staff also advises the CDFG Committee of Cooperative Research for the Assessment of Nearshore Ecosystems, which is determining statewide protocols for standardized underwater methods to survey nearshore fish populations.

## **Marine Protected Areas**

Our staff has initiated and led the efforts to evaluate Marine Protected Areas (MPAs) as a supplemental tool for groundfish management on the West Coast. Early on, our staff organized and convened the first workshop on marine harvest refugia to conserve and manage rockfishes and continued these discussions in a special symposium on marine protected areas for California. Staff served as advisers to the Pacific Fisheries Management Council and produced a technical analysis and report to assist the Council in developing marine reserves as part of a long term Council fishery management program. These published proceedings and reports continue to be used by West coast states in evaluating marine reserves as a strategy to conserve and manage nearshore marine resources. A staff member is an appointed scientific advisor on the Master Plan Team for California's Marine Life Protection Act, which is assisting in developing recommendations for Marine Protected Area Networks to the state's Fish and Game Commission. Our staff also serves as scientific advisor to representatives of the fishing community on the central coast, organized as the Alliance of Communities for Sustainable Fisheries. Most recently a staff member was invited to participate in an NCEAS (National Center for Ecological Analysis and Synthesis) working group "Development of Tools for the Practical Design of Marine Reserves". Several research efforts have been identified by this working group to be pursued over the next several years; one paper on the ecological consequences of phasing in networks of MPAs is ready for journal submission.

The National Marine Protected Area Center (NMPAC) Science Institute, established under Executive Order 13158 on MPAs, is co-located at the Santa Cruz Laboratory. The Science Institute provides coordination and support of MPA research, design, monitoring schemes and management strategies. MPAs are now a cross cutting issue within NOAA Fisheries and are being evaluated and implemented for a host of purposes ranging from stock rebuilding plans to endangered species protection. Our new staff member (Lisa Wooninck) served a detail to the NMPAC at NOAA headquarters in Silver Spring, and has continued to work on several MPA related projects for the NMPAC and NOAA Fisheries. Currently we are leading efforts to develop a NOAA Fisheries strategy for MPAs. Integral to development of this strategy is an evaluation of the existing NMFS MPAs (or area based management measures). The results of the evaluation will be presented at the annual Fishery Management Council Chairs and Executive Directors meeting by Dept. Asst. Administrator Rebecca Lent in early 2003 and also may be used for a NMFS workshop on science based strategies to improve MPA effectiveness for fisheries. Our staff also is producing a report on MPAs as research reserves to develop criteria that could guide Council debate on MPAs as tools to research and protect essential fish habitat (EFH).

## **Publications**

- "The Rockfishes of the Northeast Pacific", UC Press, which has been well-received by colleagues and the public (Love, Yoklavich, Thorsteinson).
- Produced and published Final Report "Deepwater habitat and fish resources associated with a marine ecological reserve: implications for fisheries management" to Marine Ecological Research Reserve Program, UC Sea Grant College System (Yoklavich, M.M. and G.M. Cailliet; two CDs).
- Produced draft manuscripts for publication of past research on age, growth, description of rockfishes.

## **Presentations**

- Collaboration with colleagues at NWFSC on data analyses of fish-habitats of Heceta Bank (several presentations have been made at various scientific meetings).
- Presentation of Big Creek Ecological Reserve research at a regional AIFRB meeting.
- Presentation on Big Creek Ecological Reserve research project at annual CalCOFI meetings.
- Poster Presentation "Rockfishes of Monterey Bay National Marine Sanctuary" at Monterey Bay National Marine Sanctuary Symposium.
- Presentations "Seagrass landscapes: Linking fish distributions with spatially structured habitat" at:
  - (a) NOAA-Fisheries Santa Cruz Lab
  - (b) USGS Menlo Park
  - (c) University of California, Santa Cruz
  - (d) Moss Landing Marine Laboratory April 2002.
- Preliminary results of laser project presented as poster at Sanctuary Currents Annual meeting (best poster award).
- Presentation "Laser line scan technology to characterize deepwater habitats and associated organisms" at GeoHab: Marine Geological Habitat Mapping Conference.

## **Committees and Service**

- Member, F/PR Candidate Species Panel to allocate funding for research on marine species of concern to NMFS and develop new list of candidate species (1997-2002).
- Member of Graduate Advisory Committee for Moss Landing Marine Laboratories Master's Student in Marine Science.
- NMFS science advisor to west coast groundfish EFH EIS process.
- SWFSC representative to NMFS Our Living Oceans Habitat document development.
- Member of CDFG Committee to determine statewide protocols for standardized underwater methods to survey nearshore fish populations (CRANE - Cooperative Research for the Assessment of Nearshore Ecosystems).
- State of California Marine Life Protection Act Plan Team Member (April 2000-present).
- Alliance of Communities for Sustainable Fisheries, Scientific Advisor (2001- present).

## **Program Development**

- Extramural research support for Cowcod Conservation Area Surveys:
  - Packard Foundation \$250,000
  - West Coast and Polar Regions Undersea Research Center \$210,000
  - NMFS F/PR \$70,000

NOAAs MPA Science Center \$27,500

NMFS F/HC EFH \$70,000

- Successful recruitment of NMFS-USGS post-doctoral fellow and development of research project.
- Successfully recruited Research Fishery Biologist (GS-11) to our habitat team (vice-Silberberg).
- Collaborative research with MLML Habitat Center to map seafloor habitat information off California.
- Completed laser line scan field test; preliminary data analyzed and further data analyses are ongoing.
- Preliminary results of laser project posted on three NOAA web sites (NURP, OAR, and Ocean Exploration).
- Collaboration with colleagues at U. New Hampshire on post-processing of data from the laser line scan cruise.
- Completed ageing of lingcod fin rays for analyses of age and growth.
- Collaboration with colleagues at Oregon State University on a continuation of a past project "Long-term indices of annual growth in long-lived groundfishes", with funding from FATE program.

### **Meetings**

- Organized two workshops in preparation of Cowcod Conservation Area Monitoring surveys.
- Invited participant in NOAAs West Coast Ocean Exploration Workshop to identify and prioritize areas for exploration in FY04 and beyond.
- Participated in CDFG Marine Life Management Act Nearshore FMP meetings.
- Participated in PISCO training of fish and invertebrate survey methodology to standardize techniques. Taught part of the course on juvenile rockfish identification.
- MPA education pilot workshop; Wye River, MD.
- Fish Expo information booth on MPAs as a fishery management tool; Seattle, WA.
- The National Marine Managed Area Database and State Participation; Sacramento, CA  
Portland, OR and Olympia, WA.
- Invited participant in NCEAS Working Group On Marine Reserve Design.

## Early Life History Team

### Introduction

Recruitment variability in marine fishes is generally thought to be a function of processes operating in the larval or early juvenile stages. Better understanding of these processes has tremendous value in predicting the abundance of an age cohort later in life (year-class strength), and for evaluating the potential impact of both natural and human-induced environmental changes on population dynamics. Despite extensive research efforts in this field in recent decades, definitive linkages between environmental patterns and larval/juvenile survival remain elusive. Complex interactions of spatial and temporal patterns in habitat quality, physical conditions, and the community structure of interacting species presumably contribute to the difficulty in resolving discrete causal relationships. The continuing threatened status of West Coast salmonid populations and the currently developing groundfish crisis warrant more intensive research into the array of factors driving early survival. Current projects being conducted by the Early Life History Team focus on larval quality and growth rates as indicators of individual fitness. This individual variability provides the template on which mortality acts. Our research attempts to understand both the long-term evolutionary selection pressures that maintain individual variability and the short-term ecological consequences for determining year class strength.

### Objectives

- Conduct laboratory experiments to assess variability in fitness characteristics of individual larval rockfish
- Conduct field studies to evaluate natural growth patterns of juvenile steelhead and potential effects of environmental factors on life history trajectories

### Methods and Approach

#### *Fitness variability in larval rockfish*

Our hypothesis in this study is that larval quality in rockfish is a function of female age, with older females producing progeny with a greater likelihood of survival than larvae from younger females. To test this hypothesis we are collecting pregnant females in the field, holding them in the laboratory until parturition, and monitoring subsequent growth and survival of larvae held under two ration levels (no food and ad libitum rations of live rotifers). These experiments will be conducted with several species of rockfish to test for the generality of any age-related trends in quality of progeny. Specific methods are as follows: Algae and rotifer cultures are established and maintained to provide food for larval fish. Adult females are held in partial flow-through seawater tanks, with water chilled to 12°C. Impending parturition is determined via catheterization of pregnant females. At that time, the female is sacrificed, larvae are removed, and replicate tanks are established with 500 larvae in each. A sample of larvae at parturition is analyzed for proximate composition and photographs are taken with an image analysis system, allowing subsequent measurement of body size and oil globule volume. The adults are measured

for length, wet weight, and liver weight, and otoliths removed for aging. Experimental treatments include unfed and fed larvae, with dead larvae removed daily to estimate mortality rates, and a sample of larvae from each replicate of the fed treatment removed every 3 d for estimation of growth rates. Larval growth and mortality are compared with female age, indices of energy content (total lipids and oil globule volume) and morphometric indices.

### *Analysis of growth patterns in juvenile steelhead*

Steelhead exhibit a remarkable plasticity of life-history trajectories, with substantial variability in timing of juvenile smoltification and timing of adult return. This variability within a cohort may have a major impact on year-class strength if mortality rates differ interannually in either freshwater rearing habitat or ocean foraging habitat. The factors that determine life-history trajectories are currently unknown, but are thought to include growth rates and condition (i.e. lipid storage), which are in turn affected by habitat quality (prey availability, temperature) and fish density. In this project we are monitoring growth of juvenile steelhead in two hatchery populations and two natural populations during their first summer growing season. Fish will be individually marked in the fall, and growth trajectories tracked into the following spring, when smoltification will be assessed. The hatchery populations are comprised of two stocks, from the San Lorenzo River and Scott Creek, held separately at the Monterey Bay Salmon and Trout Project hatchery on Scott Creek. Size-frequency distributions of the two stocks are measured on a bi-weekly basis throughout the summer, fall, and winter until the fish are released in the spring. Fish densities and size-frequency distributions of natural populations of steelhead in Scott Creek and Soquel Creek are monitored using electroshocking and other techniques in the summer, fall, and following spring. Water temperatures are continuously monitored in several locations in each stream. In the fall, a series of individuals from each group will be implanted with PIT (passive integrated transponder) tags, which allow distinction of individuals. Recaptures of these fish will be used to determine individual growth trajectories. In the spring, smoltification will be assessed using enzyme analysis of  $\text{Na}^+$ ,  $\text{K}^+$ -ATPase activity in non-lethal sampling of gill filaments. We will then evaluate the relationship between body size/condition and likelihood of outmigration at 1 year of age. We will also test for the development of discrete size modes in the fall and the correspondence between size modes and smoltification in the spring. Continued tracking of PIT -tagged individuals that remain in streams for a second year and adults upon return will provide further information on life-history consequences of variability in early juvenile growth.

### **Accomplishments**

Because this is a new program within the Santa Cruz laboratory, our accomplishments center on the setup of aquarium facilities, construction of experimental tank systems, and initiation of new laboratory and field experiments. We began operation of the seawater circulation system and chilling units in December, 2001 and began holding adult rockfish in the aquarium at that time. Experiments testing viability of copper and gopher rockfish larvae were initiated in March, 2002. We completed a full series of experiments with gopher rockfish in May. The females tested thus far have ranged in age from 7 to 16 years. Steelhead studies began in June, 2002, with bi-weekly measurement of length-frequency distributions in the two hatchery populations maintained at Big Creek Hatchery. Length-frequency data in Scott Creek is being collected on a

bi-weekly basis by the Salmon Ecology Team and will be available to us for analyses. Electroshocking has been completed in five reaches of Soquel Creek, providing extensive data on size distributions. In addition, the Soquel Demonstration State Forest has provided to use their complete datasets for electroshocking conducted over the past 10 years at four distinct locations.

### **Presentations**

- Larval Fish Conference, Bergen, Norway, July 2002

### **Committees and Service**

- Science Advisory Group, Interagency Ecology Program for analysis of the Sacramento-San Joaquin Estuary
- Secretary of the Early Life History Section, American Fisheries Society, 2000-2002
- Graduate student committees, 5 Ph.D. students at Oregon State University, 1 M.S. student at the University of Delaware, 1 M.S. student at the University of South Alabama

### **Program Development**

- Recruitment of Susan Sogard, Ecology Branch Chief
- Contract with UCSC for collaborative studies on larval quality in rockfish
- Summer student hire
- Supervision of undergraduate senior thesis, in conjunction with UCSC faculty
- Initiated recruitment of a post-doctoral research to assist with larval rockfish studies

### **Future Directions**

*Larval rockfish quality* - We have developed reliable experimental protocols for holding adult rockfish in the laboratory, maintaining healthy cultures of live rotifers to serve as prey for larvae, and establishing replicated tank systems for monitoring larval growth and survival under constant temperatures. We will continue and expand the experiments on larval growth and mortality, with a goal of examining as wide an age distribution of adult females as possible. The species examined will be expanded as room in the laboratory allows and depending on availability of pregnant females in the field. Likely candidates include gopher, copper, kelp, yellowtail, and china rockfish. We will also begin collecting information on natural age distributions of these species, and evaluate any evidence for fishing-induced age truncation. We are currently recruiting a post-doctoral researcher to supervise the laboratory experiments and develop related, independent studies addressing larval growth and survival questions, with potential expansion to field studies of early juvenile transport, settlement, and survival processes.

*Steelhead life history variation* - We will continue monitoring growth rates of natural steelhead populations, potentially expanding our efforts to additional watersheds. Ideally we will examine systems that naturally vary in productivity levels and fish densities, allowing us to evaluate effects of food availability and social interactions on growth rates and subsequent life history trajectories. The Scott Creek hatchery populations will be monitored on a continuing basis. In addition, we are commencing laboratory experiments to test the effects of temperature, food, fish density, photoperiod, and other factors on growth and smoltification processes. This will require the development of recirculating freshwater systems in the aquarium facility. An undergraduate

student will be conducting a senior thesis project with us during FY '03, using laboratory experiments to test growth and behavior patterns during the first winter.



## **APPENDIX A**

### **CURRICULA VITAE OF THE SANTA CRUZ LABORATORY**



## CURRICULUM VITAE

**NAME: PETER B. ADAMS**

**PRESENT POSITION:** Research Fishery Biologist, Fisheries Branch Chief

**EDUCATION:** Ph.D., Ecology, University of California, Davis, 1988; M.S., Ecology, University of California, Davis, 1973; B.S., Biology, University of Redlands, 1970.

**PAST EXPERIENCE:**

1976-present	Fishery Biologist (Research) National Marine Fisheries Service Santa Cruz and Tiburon, California
1999-present	Research Associate Institute of Marine Science University of California, Santa Cruz
1995-present	National Research Council Post-doctoral Fellow
1976	Sea Grant Trainee University of California, Davis

**RESEARCH INTERESTS:** Modeling of populations and communities, stock assessment, dynamics of exploited populations, statistical analysis, particularly sampling, and line transect population estimates of deep slope groundfishes.

**HONORS AND AWARDS:** Performance Awards, 1992, 1994, 1996, 1998, 1999, 2000; Outstanding Article in Fishery Bulletin, 1980; Jastro Fellowship, University of California, Davis; Magna Cum Laude, University of Redlands.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** ESA Biological Review Teams for coho salmon, chinook salmon, and steelhead.

### SELECTED PUBLICATIONS:

Adams, P. B., E. H. Williams, K. R. Silberberg and T. E. Laidig. 1999. Southern Lingcod Stock Assessment in 1999. *In* Status of the Pacific coast groundfish fishing throughout 1999 and recommended biological catches for 2000. Pacific Fishery Management Council, Portland, Oregon. Appendix, 79 p. Pacific Fishery Management Council, Portland OR.

Adams, P. B., M. J. Bowers, H. E. Fish, T. E. Laidig, and K. R. Silberberg. 1999. Historical and Current Presence-Absence of Coho Salmon (*Oncorhynchus kisutch*) in the Central California Coast Evolutionarily Significant Unit. SWFSC Administrative Report SC-99-02. 26 p.

Adams, P. B. and D. F. Howard. 1996. Natural mortality of blue rockfish *Sebastes mystinus* during their first year in nearshore benthic habitats. Fish. Bull., U.S. 94(1):156-162.

Adams, P. B., J. H. Butler, C. H. Baxter, T. E. Laidig, K. Dahlin, and W. W. Wakefield. 1995. Population estimates of Pacific coast groundfishes from video transects and swept-area trawls. Fish. Bull., U.S. 93:446-455.

Adams, P. B. 1980. Life history patterns in marine fishes and their consequences for fisheries management. Fish. Bull., U.S. 78:1-12.

Lenarz, W. H. and P. B. Adams. 1980. Some statistical considerations of the design of trawl surveys for rockfish (Scorpaenidae). Fish. Bull., U.S. 78(3):659-674.

## CURRICULUM VITAE

**NAME:** ADITYA AGRAWAL

**PRESENT POSITION:** Research Associate (GIS Analyst), Salmon Population Analysis Team

**EDUCATION:** MA, Geographic Information Science for Development and Environment, Clark University, Worcester, MA, 2001; BA, Geography, minor in Anthropology, University of Minnesota, Minneapolis, MN, 1999

<b>PAST EXPERIENCE:</b>	2002-present	Research Associate NOAA Fisheries, Southwest Fisheries Science Center Santa Cruz, California
	2001	Teacher's Assistant Clark University Worcester, Massachusetts
	2001	GIS Intern Wildlife Conservation Society Bronx, New York

**RESEARCH INTERESTS:** use of geographical information science (GIS) to conduct spatial analyses in development, ecology, and archaeology applications; deriving methods for creating models for suitability and risk analysis and change over time; remote sensing.

## CURRICULUM VITAE

**NAME:** TARA ANDERSON

**PRESENT POSITION:** Post Doctoral Fellow

**EDUCATION:** PhD, Melbourne University, Australia, (*pending*); MSc, Zoology, Auckland University, New Zealand, 1994; BSc, Biology, Auckland University, New Zealand, 1991.

**PAST EXPERIENCE:**

2001-present	Post Doctoral Fellow Joint NMFS/SWFSC and USGS Menlo park. Santa Cruz, California
1996 - 1997	Fishery Scientist Australian Institute of Marine Sciences Townsville, Queensland, Australia.
1994 - 1996	Senior Research Assistant Marine Biology Department, James Cook University Townsville, Queensland, Australia.

**RESEARCH INTERESTS:** Organism-habitat relationships, measuring spatial pattern from large scale landscapes and habitat mosaics down to fine-scale microhabitat associations, groundfish distribution patterns, habitat mapping, fish-seagrass associations.

**HONORS AND AWARDS:** Australian Postgraduate Award 1997-2000. Australian Interstate Student Award 1997. AMSA Biology Travel Award 1997. New Zealand Graduate Scholarship 1992-94. New Zealand Society of Arts Scholarship 1988.

### SELECTED PUBLICATIONS:

Anderson, T.J. (1999). Morphology and biology of *Octopus maorum* Hutton 1880 in northern New Zealand. *Bulletin of Marine Science* 65(3): 657-676.

Anderson, T.J. Babcock, R. (1999). Subcutaneous electromagnetic tagging of benthic octopus: a preliminary evaluation. *Marine and Freshwater Research* 50:225-227.

Anderson, T.J. (1997). Factors influencing habitat association and shelter use of *Octopus tetricus*. *Marine Ecology Progress Series* 150:137-148.

## CURRICULUM VITAE

**NAME: KENNETH A. BALTZ**

**PRESENT POSITION:** Oceanographer, Groundfish Population Analysis Team

**EDUCATION:** M.S., Physical Oceanography, Naval Postgraduate School, 1997; B.S., Marine Biology, Florida Institute of Technology, 1987.

**PAST EXPERIENCE:**

1999-2000	Computer Specialist Information Technology Services, NOAA/NMFS Santa Cruz/Tiburon Laboratory
1997-1999	Field Operations Officer NOAA Ship CHAPMAN and NOAA Ship GORDON GUNTER Office of NOAA Corps Operations and NMFS SEFSC Pascagoula, MS
1993-1997	Fisheries Oceanographer (Research and Databases Support) NMFS/SWFSC Tiburon, California (93-95) and Pacific Grove, CA (95-97)
1991-1993	Navigation and Field Operations Officer NOAA Ship Townsend Cromwell Office of NOAA Corps Operations and NMFS SWFSC, Honolulu, HI
1989-1990	Environmental/Ecology Educator and Charter Boat Captain Marine Sciences Under Sails, Hollywood, FL
1987-1989	Animal Trainer for Orcas Sea World of Florida, Orlando, FL

**RESEARCH INTERESTS:** Information Technologies, Physical Oceanographic Impacts to Fisheries, Air - Sea Interface Dynamics, Pacific Groundfish.

**HONORS AND AWARDS:** NOAA Special Achievement Awards, 1994 & 1996; Pacific Service Ribbon, 1993; Atlantic Service Ribbon, 1999; Beta Beta Beta Biological Honor Society.

### SELECTED PUBLICATIONS:

Baltz, K.B. 1997. Ten years of hydrographic variability off central California during the upwelling season. Naval Postgraduate School Technical Rep., NPS-OC-97-008, 319p.

Schwing, F.B., T.L. Hayward, K.A. Baltz, T. Murphree, K.M. Sakuma, A.S. Mascarenas Jr., A.W. Mantyla, S.I. Castillo, S.L. Cummings, D.G. Ainley, and F. Chavez. 1997. The state of the California Current, 1996-1997: mixed signals from the tropics. CalCOFI Reports, Vol. 38.

Sakuma, K.M., F.B. Schwing, K.A. Baltz, D. Roberts, S. Ralston. 1997. The physical oceanography off the central California coast during May-June, 1996: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dept. of Commerce. NOAA-TM-NMFS-SWFSC-246, 155p.

Schwing, F.B., M. O'Farrell, J.M. Steger, K.A. Baltz. 1996. Coastal upwelling indices, west coast of North America, 1946-95. U.S. Dept. of Commerce. NOAA-TM-NMFS-SWFSC-231, 207p.

Sakuma, K.M., F.B. Schwing, K.A. Baltz, D. Roberts, H.A. Parker, S. Ralston. 1996. The physical oceanography off the central California coast during May-June, 1995: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dept. of Commerce. NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-232, 144p.

**CURRICULUM VITAE**

**NAME: CHARLENE E. BERGERON**

**PRESENT POSITION:** Laboratory Assistant II (Research Fishery Biologist)

**EDUCATION:** B.S., Marine Biology, University of California Santa Cruz, 1998

**PAST EXPERIENCE:**

2001-Present	Research Fishery Biologist/Laboratory Assistant National Marine Fisheries Service Santa Cruz, California
2000-2001	Fish Culturist Armin F. Koernig Hatchery Prince William Sound Aquaculture Corporation Cordova, Alaska
1998-2000	Fish Technician Cannery Creek Hatchery Prince William Sound Aquaculture Corporation Cordova, Alaska

**RESEARCH INTERESTS:** Salmon life history, ecology, distribution, and stream survey methods.

## CURRICULUM VITAE

**NAME: ERIC P. BJORKSTEDT**

**PRESENT POSITION:** Research Fisheries Biologist, Salmon Population Analysis Team  
Research Associate, Institute of Marine Sciences, University of California, Santa Cruz  
Adjunct Professor, Department of Fisheries, Humboldt State University

**EDUCATION:** Ph.D., Ecology, Stanford University, 1998; Honors B.A., Biology and English, University of Delaware, 1992.

**PAST EXPERIENCE:** 1998-present      Research Fisheries Biologist  
NOAA Fisheries, Southwest Fisheries Science Center  
Santa Cruz, California

1998                              NRC Postdoctoral Research Associate  
NOAA Fisheries, Northwest Fisheries Science Center  
Seattle, Washington

**RESEARCH INTERESTS:** Population and metapopulation dynamics of anadromous salmonids; biological and physical processes affecting recruitment and population structure in coastal marine fishes; application of remote sensing in ecological research; life history evolution and behavioral ecology of marine and anadromous fish; theoretical and statistical ecology.

**HONORS AND AWARDS:** Department of Commerce Bronze Medal, 2000; Performance Award, 2000; National Research Council Postdoctoral Research Associateship, 1998; Excellence in Teaching Award, Department of Biological Sciences, Stanford University, 1995, 1997; Norman K. Wessels Award for Outstanding Performance as a Teaching Assistant, Stanford University, 1994; National Science Foundation Graduate Research Fellowship, 1993; Phi Beta Kappa University of Delaware, 1991.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** North-Central California Coast Technical Recovery Team (Chair); ESA Biological Review Team for Klamath Mountain Province steelhead

### SELECTED PUBLICATIONS:

Bjorkstedt, E. P., L. K. Rosenfeld, B. A. Grantham, Y. Shkedy, and J. Roughgarden (in press) Distributions of larval rockfish (*Sebastes* spp.) across nearshore fronts in a coastal upwelling region. Marine Ecology Progress Series.

Spence, B.C., T.H. Williams, E. P. Bjorkstedt, and P.B. Adams (2001) Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coast Evolutionarily Significant Units. NMFS, SWFSC, Santa Cruz, 111 p.

Bjorkstedt, E. P. (2000) DARR (Darroch Analysis with Rank-Reduction): A method for analysis of stratified mark-recapture data from small populations, with application to estimating abundance of smolts from outmigrant trap data. U.S. Dep. Commer., NOAA, NMFS, SWFSC, Admin. Rep., Santa Cruz, SC-00-02. 28 p.

McElhany P., Ruckelshaus M., Ford M. J., Wainwright T., Bjorkstedt E. P. (2000) Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Depart. Commer., NOAA Technical Memorandum NMFS-NWFSC-42, 156 p.

Bjorkstedt, E. (2000) Stock-recruitment relationships for life cycles that exhibit concurrent density dependence. Canadian Journal of Fishery and Aquatic Sciences 57(2): 459-467.

## CURRICULUM VITAE

**NAME: DAVID A. BOUGHTON**

**PRESENT POSITION:** Research Ecologist, Salmon Population Analysis Team

**EDUCATION:** Ph.D., Ecology, University of Texas Austin, 1998. A.B. magna cum laude, Ecology and Systematics, Cornell University, 1988.

<b>PAST EXPERIENCE:</b>	2001-present	Research Ecologist NOAA Fisheries, Southwest Fisheries Science Center Santa Cruz, California
	1999-2001	Research Ecologist USDA Forest Service, Pacific NW Research Station Corvallis, Oregon
	1998-1999	Ecologist US EPA, Office of Research and Development Research Triangle Park, North Carolina
	1988-1991	Programmer/Taxonomist Ichthyology, California Academy of Sciences San Francisco, California

**RESEARCH INTERESTS:** Population and metapopulation dynamics; local adaptation of animal behavior and life history, especially dispersal systems; complex life histories; landscape ecology including interaction of ecological and economic systems. Mathematical ecology, evolution, statistics.

**HONORS AND AWARDS:** USDA Science Findings Award, 2001. NSF International Postdoctoral Fellowship, 1998. Ecological Society of America Buell Award, 1998 (honorable mention). Sigma Xi, University of Texas, 1997. Annual Symposium Invitee, Environmental Defense Fund, 1997. STAR Fellow, US Environmental Protection Agency, 1996. National Science Foundation, dissertation improvement grant, 1995. University of Texas Austin, continuing fellowship, 1995. National Science Foundation, predoctoral fellowship 1991. Distinction in all subjects, Cornell University (1988)

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Chair, So. Calif. Recov. Domain TRT, pending. Modelling Workgroup, Survey and Manage Prog. (USDA and BLM), 1999-2000. Chair, Soc. Conserv. Biol., Univ. Texas Chapter 1991-92.

### SELECTED PUBLICATIONS:

Boughton, D.A. & U. Malvadkar. 2002. Extinction risk in successional landscapes subject to catastrophic disturbances. *Conservation Ecology*.

Boughton, D.A. 2000. The dispersal system of a butterfly: a test of source-sink theory suggests the intermediate-scale hypothesis. *American Naturalist* 145: 131 - 144.

Boughton, D.A. 1999. Empirical evidence for source-sink dynamics in a butterfly: Temporal barriers and alternative states. *Ecology* 80(8): 2727 - 2739.

Boughton, D.A., B.B. Collette & A.R. McCune. 1991. Heterochrony in jaw morphology of needlefishes (Belontiidae: Teleostei). *Systematic Zoology* 40(3): 329 - 354.

## CURRICULUM VITAE

**NAME: CHRISTOPHER J. DONOHOE**

**PRESENT POSITION:** Staff Research Associate IV

**EDUCATION:** Ph.D., Oregon State University (Fisheries Science). 2000; M.S., San Diego State University (Biology; Ecology), 1990; B.S., Florida Institute of Technology (Marine Biology), 1980.

**PAST EXPERIENCE:**

2002 - present	Staff Research Associate IV University of California, Santa Cruz Santa Cruz, CA
1991 - 2000	Graduate Research Assistant / Teaching Assistant / Graduate Student Department of Fisheries and Wildlife, Oregon State University Corvallis, OR
1985-1991	Research Assistant Department of Biology, San Diego State University San Diego, CA.
1980-1982	Research Assistant Harbor Branch Oceanographic Institution Fort Pierce, FL

**RESEARCH INTERESTS:** Relationships among life history forms in salmonids, early life history strategies of fishes, environmental and ontogenetic variation in otolith microchemistry, fisheries oceanography and recruitment of coastal fishes, age and growth of fishes.

**HONORS AND AWARDS:** AIFRB Research Assistance Award, 1996; ASIH Best Student Paper, runner up, 1994.

### SELECTED PUBLICATIONS:

Donohoe, C. J., and D. F. Markle. in prep. Metamorphosis and relationships to otolith microstructure and growth in Pacific sanddab, *Citharichthys sordidus* (Paralichthyidae).

Donohoe, C. J., and D. F. Markle. in prep. Settlement, distribution, and abundance of age-0 Pacific sanddab (*Citharichthys sordidus*) on the Oregon continental shelf.

Donohoe, C. J., and D. F. Markle. in prep. Ontogenetic and individual variation in otolith microchemistry of two recently-settled flatfishes, Dover sole (*Microstomus pacificus*) and Pacific sanddab (*Citharichthys sordidus*).

Donohoe, C. J., and D. F. Markle. in prep. Sources of variation in time series of otolith growth of settling Pacific sanddab, *Citharichthys sordidus* (Paralichthyidae).

Toole, C.L., D.F. Markle, and C.J. Donohoe. 1997. Settlement timing, distribution, and abundance of Dover sole (*Microstomus pacificus*) on an outer continental shelf nursery area. Canadian Journal of Fisheries and Aquatic Sciences. 54: 531-542.

Donohoe, C.J. 1997. Age, growth, distribution, and food habits of recently settled white seabass, *Atractoscion nobilis*, off San Diego County, California. Fishery Bulletin. 95:709-721.

## CURRICULUM VITAE

**NAME: HEIDI E. FISH**

**PRESENT POSITION:** Research Fishery Biologist, Salmon Population Analysis Team

**EDUCATION:** B.S., Zoology, California State University Long Beach, 1983.

**PAST EXPERIENCE:**

1997-present	Research Fishery Biologist National Marine Fisheries Service Santa Cruz, California
1996	Biological Science Technician National Marine Fisheries Service Tiburon California
1990-1996	Fish and Wildlife Scientific Aide California Department of Fish and Game Long Beach and Menlo Park, California

**RESEARCH INTERESTS:** Salmon life history and stream survey methods.

**HONORS AND AWARDS:** Certificate of Recognition, 1997.

**PROFESSIONAL AFFILIATIONS:** American Fisheries Society

### SELECTED PUBLICATIONS:

Laidig, Thomas E., Peter B. Adams, Kelly R. Silberberg and Heidi E. Fish. 1997. Conversions between total, fork and standard lengths for lingcod, *Ophiodon elongatus*. California Fish Game 83:128-129.

Adams, Peter B., Michael J. Bowers, Heidi E. Fish, Thomas E. Laidig and Kelly R. Silberberg. 1999. Historical and Current Presence-Absence Data of Coho Salmon (*Onchorhynchus kisutch*) in the Central California Coast Evolutionarily Significant Unit. U.S. Dep. Commer., NOAA, NMFS, SWFSC Admin. Rep., Tiburon, SC-99-02.

## CURRICULUM VITAE

**NAME: JOHN CARLOS GARZA**

**PRESENT POSITION:** Research Geneticist, Salmon Ecology Team

**EDUCATION:** Ph.D., Integrative Biology, University of California, Berkeley, 1998; M.S., Biology, University of California, San Diego, 1991; B.S., Biology, University of California, San Diego, 1990.

**PAST EXPERIENCE:**

2001-present	Assistant Adjunct Professor of Ocean Sciences University of California, Santa Cruz
2000-present	Research Fellow Institute of Marine Sciences University of California, Santa Cruz
1998-1999	Visiting Scientist Laboratoire Génome et Populations University of Montpellier, France

**RESEARCH INTERESTS:** Molecular Ecology; Population Genetics; Phylogeography; Genetic Basis of Complex Traits; Genetics of Stock Management

**HONORS AND AWARDS:** National Science Foundation Postdoctoral Fellowship, 1998; University of California President's Postdoctoral Fellowship, 1998; Sigma Xi Grant in Aid of Research, 1997; UCB Chancellor's Dissertation Year Fellowship, 1997; Ford Foundation Dissertation Year Fellowship, 1997; National Science Foundation Doctoral Dissertation Improvement Grant, 1996; UCB Vice Chancellor of Research Dissertation Grant, 1996; UC Natural Reserve System Mildred Mathias Research Grant, 1993; Ford Foundation Predoctoral Fellowship, 1992-96; UCSD Chancellor's Volunteer Award, 1991; Phi Beta Kappa Honor Society, 1989; UCSD Alumni Association: Scholar of the Year (Twice), 1988-90; UCSD Provost's Honor Roll (5 times), 1987-90.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** ESA Salmonid Central California Coast Technical Recovery Team, 2001; Saltonstall-Kennedy Grant Reviewer, 2001; Russian River Coho Salmon Work Group, 2001.

### SELECTED PUBLICATIONS:

Wlasiuk G, Garza JC, Lessa E (2002) Genetic and geographic differentiation in the Rio Negro tuco-tuco (*Ctenomys rionegrensis*): distinguishing historical and contemporary gene flow. *Evolution*: in press.

Garza JC, Williamson E (2001) Detection of reduction in population size using data from microsatellite DNA. *Molecular Ecology* 10: 305-318

Garza JC, Desmarais E (2000) Derivation of a simple microsatellite locus from a compound ancestor in the genus *Mus*. *Mammalian Genome* 11: 1117-1122.

Weber DS, Stewart BS, Garza JC, Lehman N (2000) An empirical genetic assessment of the severity of the northern elephant seal population bottleneck. *Current Biology* 10: 1287-1290 (cover photo).

Garza JC, Dallas J, Duryadi D, Gerasimov S, Croset H, Boursot P (1997) Social structure of the Mound-building mouse, *Mus spicilegus*, revealed by genetic analysis with microsatellites. *Molecular Ecology* 6: 1009-1017 (cover photo).

Garza JC, Freimer NB (1996) Homoplasmy for size at microsatellite loci in humans and chimpanzees. *Genome Research* 6: 211-217.

Garza JC, Slatkin M, Freimer NB (1995) Microsatellite allele frequencies in humans and chimps with implications for constraints on allele size. *Molecular Biology and Evolution* 12: 594-603.

## CURRICULUM VITAE

**NAME: ELIZABETH ALICE GILBERT**

**PRESENT POSITION:** Research Molecular Geneticist

**EDUCATION:** Master of Arts Degree, San Francisco State University, 2001; Bachelor of Science Degree, Oregon State University, 1989.

<b>PAST EXPERIENCE:</b>	2001 - present	Research Molecular Geneticist NOAA/NMFS Santa Cruz, California
	2001 - 2001	Marine Scientist Aquatic Farms Santa Cruz, California
	2001 - 2001	Research Technician San Francisco State University San Francisco, California
	1998 - 2001	Graduate Assistant San Francisco State University San Francisco, California

**RESEARCH INTERESTS:** Population genetics and phylogeography of marine and anadromous fishes, larval recruitment, molecular ecology.

**HONORS AND AWARDS:** Myers Oceanographic and Marine Biology Trust research grant, 1998; Lerner-Gray Fund research grant, 1999; Sigma Xi research grant, 1999.

### SELECTED PUBLICATIONS:

Gilbert, E. A. 2000. Molecular genetic analysis of temporal recruitment pulses in juvenile kelp rockfish. Master's Thesis, San Francisco State University.

## CURRICULUM VITAE

**NAME: JON GOIN**

**PRESENT POSITION:** Laboratory Assistant II (Research Fishery Biologist)

**EDUCATION:** B.S., Environmental Studies, University of California, Santa Barbara, 1998

**PAST EXPERIENCE:**

2002-Present	Research Fishery Biologist/Laboratory Assistant NOAA/National Marine Fisheries Service Santa Cruz, California
2001-2002 and 1999-2000	Watershed Aide/Fisheries Marin Municipal Water District Fairfax, California
2001	Forester East-West Forestry Associates Inverness, California
2000-2001	Environmental Scientist URS/Dames and Moore San Francisco, California

**RESEARCH INTERESTS:** Coastal salmonid life histories, distributions, and habitat utilization.

**HONORS AND AWARDS:** University of California, Santa Barbara, 1998 Excellence in the Environmental Studies Major Award

### SELECTED PUBLICATIONS:

Andrew, G.M., Ettliger, E., Goin, J., and Irons, B. 2001. Lagunitas Creek Coho Salmon Spawner Survey Report 1999-2000.

Ettliger, E., Andrew, G., and Goin, J. 2002. Juvenile Salmonid Population Monitoring Report, Lagunitas Creek, Marin County, California, Fall 1999.

Ettliger, E., Goin, J., and Andrew, G. 2002. Juvenile Salmonid Population Monitoring Report, Lagunitas Creek, Marin County, California, Fall 2001.

## CURRICULUM VITAE

**NAME: MATTHEW N. GOSLIN**

**PRESENT POSITION:** Research Associate, Salmon Population Analysis Team

**EDUCATION:** M.S., Forest Ecology, Oregon State University, 1997; B.S., Biology, Pacific Lutheran University, 1989.

**PAST EXPERIENCE:** 2002-present      Research Associate  
NOAA Fisheries, Southwest Fisheries Science Center  
Santa Cruz, California

1997-2000      Faculty Research Assistant  
Forest Resources Dept,  
Oregon State University  
Corvallis, Oregon

**RESEARCH INTERESTS:** Fire regimes and the role of moderate severity fires in Pacific Northwest forests; dynamics and spatial patterning of multiple age class forests; role of biological legacies in the post-disturbance development of plant communities; forest stand modeling; applications of spatial statistics in ecological research

**HONORS AND AWARDS:** Moltke Fellowship, College of Forestry, Oregon State U., 1992; Arete Society (academic honor society), Pacific Lutheran U., 1989; Cheney Foundation Merit Award in Natural Sciences, P.L.U., 1989; Irene Creso Scholarship in Plant Sciences, P.L.U., 1988.

### SELECTED PUBLICATIONS:

Sillett, S.C. and M.N. Goslin. 1999. Distribution of epiphytic macrolichens in relation to remnant trees in a multiple-age Douglas-fir forest. *Canadian Journal of Forest Research*. 29: 1204-1212.

## CURRICULUM VITAE

**NAME:** CHURCHILL BRAGAW GRIMES

**PRESENT POSITION:** Director, Santa Cruz Laboratory

**EDUCATION:** B.S. and M.S. Biology, East Carolina University, Greenville, North Carolina, 1967, 1971; Ph.D., Marine Sciences, University of North Carolina, Chapel Hill, 1976.

<b>PAST EXPERIENCE:</b>	1993-1998	Laboratory Director
	1984-1993	Fishery Ecologist National Marine Fisheries Service Panama City, Florida
	1983-1984	Associate Professor of Marine Fisheries
	1977-1983	Assistant Professor of Marine Fisheries Rutgers University New Brunswick, New Jersey

**RESEARCH INTERESTS:** Life history, population dynamics, fishery ecology, and recruitment dynamics.

**HONORS AND AWARDS:** Marine Science Fellowship, University of North Carolina, 1972-1973; Sigma XI; NMFS Outstanding Publication Award, *Fishery Bulletin*, Honorable Mention 1984; Outstanding Performance Award, 1987-1988, 1993-1996; Commendable Performance Award, 1989-1992; NOAA Bronze Medal 1996; American Institute of Fishery Research Biologists: Associate 1975, Member 1980, Fellow 1990; American Fisheries Society: Florida Chapter, Runner-up, Outstanding Presentation at Annual Meeting, February 1992 and 1993; Southern Division, Outstanding Achievement Award, 1996.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** National Center for Ecological Analysis and Synthesis, Open Populations Working Group, 2000-01; MexUS-Pacifico, Coastal Species Working Group Chair, 2000-01; NOAA Science Advisory Board, Science Under Multiple Mandates Panel discussant; Monterey Bay National Marine Sanctuary, Research Activities Panel, 2000-2001; East Carolina University, College of Arts & Science, Advancement Council, 2000-01.

### SELECTED PUBLICATIONS:

Sponagle, S., B. Boehlert, R.K. Cowan, C.B. Grimes, M.J. Kingsford, J.M. Leis, K. Linderman, S.G. Morgan, J.L. Munro, J. Pineda and A. Shanks. In press. Predicting self-recruitment in marine populations: biophysical correlates. *Bull Mar. Sci.*

Gieger, S.P., J.J. Tores and C.B. Grimes. In press. Measures of physiological condition in larval anchovies, *anchoa hepsetus*, collected in the discharge plume of the Mississippi River during the flood of 1993. *Mar. Ecol. Prog. Sci.*

Allman, R.J. and C.B. Grimes. 2002. Temporal and spatial dynamics of spawning, settlement, and growth of gray snapper (*Lutjanus griseus*) from the West Florida shelf as determined from otolith microstructures. *Fishery Bulletin* 100(3):391-403.

DeVries, D.A., C.B. Grimes, and M.H. Prager. 2002. Using otolith shape analysis to distinguish eastern Gulf of Mexico and Atlantic Ocean stocks of king mackerel. *Fish. Res.* 57:51-62.

Levin, P.S. and C.B. Grimes. 2002. Reef fish ecology and grouper conservation and management. In: P. F. Sale (ed.), *Coral reef fishes: dynamics and diversity in a complex ecosystem*, p. 377-389. Academic Press.

Grimes, C.B. 2001. Fishery production and the Mississippi River discharge. *Fisheries* 26:17-26.

Koenig, C.C., F.C. Coleman, C.B. Grimes, G.R. Fitzhugh, C.J. Gledhill, K.M. Scanlon and M. Grace. 2000. Protection of fish spawning habitat for conservation of warm temperate reef fish fisheries on shelf-edge reefs of Florida. *Bull. Mar. Sci.* 116:593-616.

## CURRICULUM VITAE

**NAME: JEFFREY HARDING**

**PRESENT POSITION:** Research Fishery Biologist, Salmon Ecology Team

**EDUCATION:** MS, Zoology, Oregon State University, 1993; BA, General Biology, University of California, San Diego, 1985.

**PAST EXPERIENCE:**

2002 - present	Research Fishery Biologist NMFS/SWFSC Santa Cruz Laboratory Santa Cruz, CA
2000 - 2001	Instructor (Biology, Marine Biology, Environmental Science) Monterey Peninsula College Monterey, CA
1995 - 2002	Marine Biological Technician and Data Analyst University of California Santa Cruz and Santa Barbara, CA
1994	Instructor, Oregon Inst. Marine Biology (University Of Oregon) Charleston, Oregon
1989 - 1993	Graduate Teaching Assistant and Graduate Research Assistant Oregon State University Corvallis, OR

**RESEARCH INTERESTS:** Community ecology of coastal marine ecosystems, especially temperate rocky reefs, kelp forests, and coral reefs. Current research focus is growth, physiology, and trophic ecology of Pacific salmonids. In particular, my goals as a field biologist are to study and evaluate the links between physical oceanographic conditions, coastal oceanic food webs, and juvenile salmon growth and survival in the bays, estuaries, and coastal ocean of central California.

**HONORS AND AWARDS:** Lerner-Gray Fund for Marine Research, 1992; Sigma Xi Grants-in-Aid of Research, 1992; OSU Zoology Research Fund, 1991, 1992, 1993.

### PRESENTED PAPERS:

Mate guarding as a mechanism for pairing in a coral reef fish. Western Society of Naturalists, Newport, OR. 1993.

Pair formation and stability in a monogamous coral reef fish, the cleaning goby *Gobiosoma evelynae*. Pacific Ecology Conference, Friday Harbor Laboratories, WA. 1992.

Site fidelity, pair stability, and behavior of the Caribbean cleaning goby *Gobiosoma evelynae*. OSU Biology Graduate Student Symposium, Newport, OR. 1991.

## CURRICULUM VITAE

**NAME: SEAN A. HAYES**

**PRESENT POSITION:** Research Assistant I

**EDUCATION:** Ph.D. Biology, Fall 2002; MS. Biology, 1998 University of California Santa Cruz. B.S. Biology, 1994. Cornell University. A.S. Fisheries and Wildlife Technology, 1991, State University of New York, Cobleskill.

**PAST EXPERIENCE:**

2002 - present	Research Assistant I JIMO/NMFS Santa Cruz, Ca
2001 -2001	Ecologist, GS 11 NMFS Honolulu, HI
1994-2001	Graduate Student University of California Santa Cruz Santa Cruz, CA

**RESEARCH INTERESTS:** Behavioral and physiological ecology of salmonid and pinniped species with a management emphasis.

**HONORS AND AWARDS:** American Museum of Natural History Lerner-Gray Award 1997; American Museum of Natural History Theodore Roosevelt Award 1998; American Cetacean Society Research Award 2000; Animal Behavior Society Research Grant 2000; Earl & Ethel Myers Oceanographic and Marine Biology Award 1997, 1998, 2000; GAANN Graduate Fellowship 1995-1998, 2001; SigmaXi Award 1998.

### SELECTED PUBLICATIONS:

Costa, D.P., D.E. Crocker, J. Gedamke, P.M. Webb, D. Houser, S. Blackwell, D. Waples, S. Hayes, and B.J. Le Boeuf. *In review*, Effects of the ATOC sound source on the diving behavior of northern elephant seals, *Mirounga angustirostrus*. J. Acoust. Soc. Am.

Costa, D.P and S.A. Hayes, 2000. Underwater sound and Marine Mammals. In: McGraw-Hill 2001 Yearbook of Science and Technology. pp 405-407.

Hayes, S.A., D.K. Mellinger, D. Croll, D. Costa, J.F. Borsani, 2000. An inexpensive passive acoustic system for recording and localizing wild animals. J. Acoust. Soc. Am 107(6):3552-3555.

Hayes, S.A., A. Kumar, D.P. Costa, D.K. Mellinger, J.T. Harvey, B.L. Southall, and B.J. Le Boeuf. *Submitted to Animal Behaviour*. Evaluating the function of male vocalizations in the harbor seal (*Phoca vitulina*) through playback experiments.

Van Parijs, S.M., Corkeron, P.J., Harvey, J., Hayes, S.A., Kovacs, K.M., Mellinger, D.K., Rouget, P.A., Thompson, P.M. Wahlberg, M. *In MS*. Global patterns in the display vocalizations of male harbor seals.

## CURRICULUM VITAE

**NAME: XI HE**

**PRESENT POSITION:** Fishery Biologist, Goundfish Analysis Team

**EDUCATION:** Ph.D., Oceanography and Limnology (minor: Biosystem Analysis), University of Wisconsin-Madison, 1990; M.S., Oceanography and Limnology, University of Wisconsin-Madison, 1986; B.S., Freshwater Aquaculture, Shanghai Fisheries University, China, 1982.

**PAST EXPERIENCE:**

1998 - 2002	Senior Research Scientist and Sub-program Leader CSIRO Marine Research Hobart, Australia
1996 - 1998	Aquatic Biologist Massachusetts Division of Marine Fisheries Gloucester, Massachusetts
1994 - 1996	Associate Researcher JIMAR, University of Hawaii Honolulu, Hawaii
1990 - 1994	Postdoctoral Researcher Center for Limnology, University of Wisconsin-Madison Madison, Wisconsin

**RESEARCH INTERESTS:** Population and ecosystem dynamics, food web analysis, fishing impacts on benthic habitat.

**HONORS AND AWARDS:** Lake Champlain Postdoctoral Award, University of Vermont, 1992.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Australian Fisheries Management Authority: South East Fishery Assessment Group, 1998-2002, Sub-Antarctic Fishery Assessment Group, 1999-2002. Atlantic States Fisheries Commission, Stock Assessment Subcommittee on Stripped Bass, 1995-1996.

### SELECTED PUBLICATIONS:

He, X., J.F. Kitchell and S. R. Carpenter. 1993. Food web configuration and long-term phosphorus recycling: A simulation model evaluation. *Trans. Am. Fish. Soci.* 112:773-783.

He, X. and G.W. LaBar. 1994. Interactive effects of cannibalism, recruitment, and predation on rainbow smelt in Lake Champlain: A modeling synthesis. *J. Great Lakes Research*, 20:289-298.

He, X. and G.H. Boggs. 1996. Estimating fisheries impacts using commercial fisheries data: Simulation models and time series analysis of Hawaii's tuna fisheries. *Proc. Second World Fisheries Congr. Australia*, pp593-599.

Bigelow, K.A. C.H. Boggs, and X. He. 1999. Influence of environment factors on swordfish and blue shark catch rates in the US North Pacific longline fishery. *Fishery Oceanography*, 8:178-198.

Goldsworthy, S.D., X. He, M. Lewis, R. Williams and G. Tuck. 2001. Trophic interactions between Patagonian toothfish, its fishery, and seals and seabirds around Macquarie Island. *Marine Ecology Progress Series*, 218:283-302.

Bulman, C., X. He and A. Koslow. 2002. Trophic ecology of the mid-slope demersal fish community off southern Tasmania. *J. Marine and Freshwater Research*, 53:59-72.

He, X., F. Althaus, B. Hatfield, K. Woolly, K. Sanisbury, S. Condie and P. Stephenson. In prep. Fishing impacts on benthic habitats in the Northwest Shelf of Australia: A dynamics model assessment.

## CURRICULUM VITAE

**NAME: RACHEL C. JOHNSON**

**PRESENT POSITION:** Research Fishery Biologist, Salmon Ecology Team - Student Career Experience Program

**EDUCATION:** Ph.D. candidate, Ecology and Evolutionary Biology, University of California, Santa Cruz; B.A., Biology, Wellesley College, Massachusetts, 1997.

<b>PAST EXPERIENCE:</b>	1999-present	Graduate Researcher
	1999-2000	Teaching Assistant
		University of California, Santa Cruz
	1998	Zooplankton Identification Specialist
		SWFSC Antarctic Marine Living Resources Group
		South Shetland Islands, Antarctica
	1998	Taxonomist
		California Academy of Sciences
		San Francisco, California
	1997	Tropical Marine Ecologist/ Instructor
		International Zoological Expedition
		Belize, Central America
	1995-1997	Marine Biology Teaching Assistant
		Wellesley College, Massachusetts

**RESEARCH INTERESTS:** Applied marine ecology, population biology, fishery ecology, metapopulation dynamics, and application of stable isotopes as tracers of spatial structure in populations.

**HONORS AND AWARDS:** Myers Oceanographic and Marine Biology Scholarship, 2001; Honorable Mention, NSF Graduate Research Fellowship, 1998 & 1999.

### SELECTED PUBLICATIONS:

Johnson, R.C., C.B. Grimes and C.F. Royer. (In Prep). Discrimination of hatchery and wild chinook salmon (*Onchorynchus tshawysha*) in the California Central Valley using otolith microstructure.

Johnson, R.C., and R.B. MacFarlane. (In Prep). Estuary use and growth history of juvenile Chinook salmon from the California Central Valley juvenile in the San Francisco Bay Estuary.

Jensen, G.C. and R.C. Johnson. 1999. Reinstatement and further description of *Eualus subtilis* Carvacho & Olsen, and comparison with *E. lineatus* Wicksten & Butler (Crustacea: Decapoda: Hippolytidae). *Proceeding of the Biological Society of Washington* 112(1): 133-140.

Loeb, V., R.C. Johnson and E. Linen. (In Prep). Distribution of krill, salp and other zooplankton taxa around Elephant Island during the 1998 Austral summer. *Antarctic Journal*.

## CURRICULUM VITAE

**NAME: THOMAS E. LAIDIG**

**PRESENT POSITION:** Research Fishery Biologist, Habitat Ecology Team

**EDUCATION:** M.A., Marine Biology, San Francisco State University, 1987; B.A., Aquatic Biology, University of California, Santa Barbara, 1983.

<b>PAST EXPERIENCE:</b>	1990-present	Research Fishery Biologist NMFS/SWFSC Santa Cruz and Tiburon, California
	1989-1990	Biological Technician NMFS/SWFSC Tiburon, California
	1988-1989	Biological Aid NMFS/SWFSC Tiburon, California

**RESEARCH INTERESTS:** Population dynamics, age and growth of fishes, salmonid life history and estuary residence times, video stock assessment, species identification, kelp bed ecosystems, and rockfish recruitment dynamics.

**HONORS AND AWARDS:** Certificates of Recognition, NMFS: Sustained Superior Performance Award, 1989, 1990, 1994.

### SELECTED PUBLICATIONS:

Laidig, Thomas E. 2001. Continental slope communities. In: H.A. Karl, et al. (eds.), *Beyond the Golden Gate: oceanography, geology, biology and environmental issues in the Gulf of the Farallones* (full-length technical version), p. 185-191. U.S. Geological Survey Circular 1198.

Laidig, Thomas E. 2001. Continental slope communities. In: H.A. Karl, et al. (eds.), *Beyond the Golden Gate: oceanography, geology, biology and environmental issues in the Gulf of the Farallones* (short general-audience version), p. 56-59. U.S. Geological Survey Circular 1198.

Laidig, Thomas E., Kelly R. Silberberg, and Peter B. Adams. 2001. Validation of the first, second, and third annulus from the dorsal fin rays of lingcod (*Ophiodon elongatus*). NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-306, 19 p.

Silberberg, Kelly R., Thomas E. Laidig, Peter B. Adams, and Douglas Albin. In press. Analysis of maturity in lingcod (*Ophiodon elongatus*). Cal. Fish Game.

Adams, Peter B., Erik Williams, Kelly R. Silberberg, and Thomas E. Laidig. 1999. Southern lingcod stock assessment in 1999. 53 p.

Laidig, Thomas E., and Keith M. Sakuma. 1998. Description of pelagic larval and juvenile grass rockfish, *Sebastes rastrelliger* (Family Scorpaenidae), with an examination of age and growth. Fish. Bull. 96(4):788-796.

Jagiello, Thomas, Peter Adams, Martin Peoples, Sandra Rosenfield, Kelly Silberberg, and Tom Laidig. 1997. Assessment of lingcod in 1997. Appendix: Status of the Pacific coast groundfish fishery through 1997 and recommended acceptable biological catches for 1998. Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201. 85 p.

## CURRICULUM VITAE

**NAME: STEVEN T. LINDLEY**

**PRESENT POSITION:** Ecologist, Salmon Population Analysis Team

**EDUCATION:** Ph.D. (1994) Duke University; B.A. (1989, Aquatic Biology, with Honors and Distinction); University of California at Santa Barbara.

**PAST EXPERIENCE:**

1996-present	Ecologist NMFS/SWFSC, Santa Cruz/Tiburon Laboratory
1995-1996	Research Associate Marine Laboratory, Duke University
1994-1995	Postdoctoral Fellow, Stanford University

**RESEARCH INTERESTS:** Population biology, ecosystem ecology, numerical and statistical modeling, biological oceanography, application of stable isotopes as tracers of ecological processes.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Central Valley Chinook and Steelhead Technical Recovery Team (chair); West Coast Chinook Salmon Status Review and Biological Review Teams; Green Sturgeon Biological Review Team

### SELECTED PUBLICATIONS:

Lindley, S. T. and M. H. Mohr. In press. Predicting the impact of striped bass (*Morone saxatilis*) population manipulations on the persistence of winter-run chinook salmon (*Oncorhynchus tshawytscha*). Fishery Bulletin.

Lindley, S. T., M. S. Mohr and M. H. Prager. 2000. Monitoring protocol for Sacramento River winter chinook salmon: application of statistical power analysis to recovery of an endangered species. Fishery Bulletin 98: 759–766.

Brodeur, R. D., G. W. Boehlert, E. Casillas, M. B. Eldridge, J. H. Helle, W. T. Peterson, W. R. Heard, S. Lindley and M. H. Schiewe. 2000. A coordinated research plan for estuarine and ocean research on Pacific salmon. Fisheries 25: 7–16.

Chai, F., S. T. Lindley, J. R. Toggweiler, and R. T. Barber. 2000. Testing the importance of iron and grazing in the maintenance of the high nitrate condition in the equatorial Pacific Ocean: a physical-biological model study. In: The Changing Ocean Carbon Cycle: a midterm synthesis of the Joint Global Ocean Flux Study. R. B. Hanson, H. W. Ducklow, and J. G. Field (eds). International Geosphere-Biosphere Programme Book Series 5. Cambridge University Press.

Bender, M., J. Orchardo, M. Dickson, R. Barber and S. Lindley. 1999. In vitro O<sub>2</sub> fluxes compared with <sup>14</sup>C production and other rate terms during the JGOFS Equatorial Pacific experiment. Deep Sea Research 46: 637–654.

Lindley, S. T. and R. T. Barber. 1998. Phytoplankton response to natural and experimental iron enrichment. Deep Sea Research. 45: 1135–1150

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U. S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

Foley, D. G., T. D. Dickey, M. J. McPhaden, R. R. Bidigare, M. R. Lewis, R. T. Barber, S. T. Lindley, C. Garside, D. V. Manov and J. D. McNeil. 1997. Longwaves and primary productivity variations in the equatorial Pacific at 0°, 140°W. Deep Sea Research II 44: 1801–1826.

## CURRICULUM VITAE

**NAME:** ALEC D. MacCALL

**PRESENT POSITION:** Supervisor, Groundfish Analysis Team

**EDUCATION:** Ph.D., Oceanography, Scripps Institution of Oceanography, University of California at San Diego, 1983; M.A., Biology, California State University at Long Beach, 1979; .B.A., Biology (with Distinction), University of Rochester, Rochester, New York 1969.

<b>PAST EXPERIENCE:</b>	1997 - 2000	Chief, Groundfish Analysis Branch
	1988 - 1997	Director, NMFS/SWFSC/Tiburon Laboratory
	1982 - 1988	Fishery Biologist (Research) NMFS/SWFSC, La Jolla, California
	1974 - 1982	Marine Biologist (At separation - Senior Marine Biologist) California Department of Fish and Game c/o National Marine Fisheries Service La Jolla, California
	1986 - 1990	Adjunct Assistant Professor of Oceanography Scripps Institution of Oceanography, UCSD

**RESEARCH INTERESTS:** Population dynamics, ecology of fisheries, low frequency environmental variability, design of fishery management strategies.

**HONORS AND AWARDS:** California Department of Fish and Game Director's Award, 1978; Research Fellowship, Sea Fisheries Research Institute, Department of Agriculture and Fisheries, Republic of South Africa, 1982; Washington Sea Grant Lecturer in Recruitment Oceanography, 1986.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Pacific Fishery Management Council: Northern Anchovy Plan Development Team, 1976-1988, Jack Mackerel Plan Development Team, 1978-1981, Scientific and Statistical Committee, 1988-1995, Groundfish Management Team, 1998-present. California Sea Grant: California Sea Grant Committee, Member, 1988-1990. Pacific Seabird Group: Committee on Seabird-Fishery Interactions, Member, 1978-1985, Chairman, 1986-1991.

### SELECTED PUBLICATIONS:

MacCall, Alec D. 2002. Fishery management and stock rebuilding prospects under conditions of low frequency environmental variability and species interactions. *Bull. Mar. Sci.* 70:613-628.

MacCall, Alec D. 2002. Use of known-biomass production models to determine productivity of west coast groundfish stocks. *N. Am. J. Fish. Mgmt.* 22:272-279.

MacCall, Alec D., and Stephen Ralston. 2002. Is logarithmic transformation really the best procedure for estimating stock-recruitment relationships? *N. Am. J. Fish. Mgmt.* 22:339-350.

MacCall, Alec D. 2002. Status of bocaccio off California in 2002. PFMC, Portland OR.

MacCall, Alec D., and Xi He. 2002. Bocaccio rebuilding analysis for 2002. PFMC, Portland, OR.

## CURRICULUM VITAE

**NAME: R. BRUCE MacFARLANE**

**PRESENT POSITION:** Salmon Ecology Team Leader

**EDUCATION:** Ph. D., Oceanography, Florida State University, 1980; M.S., Oceanography, Florida State University, 1970; B.S., Zoology, Pennsylvania State University, 1968.

**PAST EXPERIENCE:**

1980-present	Research Fishery Biologist NMFS/SWFSC Santa Cruz and Tiburon, California
1978-1980	Instructor, Department of Oceanography Florida State University Tallahassee, Florida

**RESEARCH INTERESTS:** Salmon biology, physiological ecology, biochemistry of fishes, pollutant dynamics, biological/chemical oceanography.

**HONORS AND AWARDS:** National Research Council Post-doctoral Fellow Advisor, 1998-present; Outstanding Performance Award, NOAA/NMFS/SWFSC, 1984, 1990, 1994-5, 1997, 1999-2000; Quality Step Increase, NOAA/NMFS/SWFSC, 1990, 1998; Sustained Superior Performance Award, 1985, 1986; Commendation for Technical Advice, Aquatic Habitat Program, Resolution #85-16, San Francisco Bay Regional Water, Quality Control Board, Oakland, California, 1985; Society of Sigma Xi Doctoral Assistance Grant, Florida State University, 1978;

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Technical Advisor to EPA for Section 301(A) of Clean Water Act; Aquatic Habitat Program, Regional Effects Technical Advisory Committee, California State Water Resources Control Board; San Francisco Estuary Project, Technical Advisory Committee, U.S. EPA, Region IX, San Francisco; CALFED Technical Advisory Group; NMFS/CDFG Anadromous Fish Hatchery Review Committee.

### SELECTED PUBLICATIONS:

Eldridge, M. B., E. C. Norton, B. M. Jarvis, and R. B. MacFarlane. In press. Energetics of early development in the viviparous yellowtail rockfish. *Journal of Fish Biology*.

MacFarlane, R. B., S. Ralston, C. Royer, and E. C. Norton. 2002. Influences of the 1997- 1998 El Niño and 1999 La Niña on juvenile chinook salmon in the Gulf of the Farallones. PICES Scientific Report No. 20:25-29.

MacFarlane, R.B. and E.C. Norton. 2002. Physiological ecology of juvenile chinook salmon (*Oncorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and the Gulf of the Farallones, California. *Fish. Bull.* 100:244-257.

Norton, E.C., R.B. MacFarlane, and M.S. Mohr. 2001. Lipid class dynamics during development in early life stages of shortbelly rockfish and their application to condition assessment. *Journal of Fish Biology* 58:1010-1024.

MacFarlane, R.B. 2000. Use of the San Francisco Estuary by juvenile chinook salmon. In *Fish migration and passage*, (J. Cech, Jr., S. McCormick, and D. MacKinlay, eds.) International Congress on the Biology of Fish, American Fisheries Society, pp. 41-45.

MacFarlane, R.B. and E.C. Norton. 1999. Nutritional dynamics during embryonic development in the viviparous genus *Sebastes* their application to the assessment of reproductive success. *Fishery Bulletin*, U.S. 97:273-281.

MacFarlane, R.B. and M.J. Bowers. 1995. Matrotrophic viviparity in the yellowtail rockfish *Sebastes flavidus*. *J. exp. Biol.* 198:1197-1206.

MacFarlane, R.B., E.C. Norton, and M.J. Bowers. 1993. Lipid dynamics in relation to the annual reproductive cycle in yellowtail rockfish (*Sebastes flavidus*). *Canadian Journal of Fisheries and Aquatic Sciences* 50:391-401.

## CURRICULUM VITAE

**NAME: MICHAEL S. MOHR**

**PRESENT POSITION:** Mathematical Statistician and Team Leader, Salmon Population Analysis

**EDUCATION:** Graduate study, Biostatistics, University of California, Berkeley, California; M.S., Fisheries, Humboldt State University, Arcata, California, 1986; B.A., Mathematics, Humboldt State University, 1983; B.S., Fisheries, Humboldt State University, 1980.

**PAST EXPERIENCE:**

1996-present	Mathematical Statistician National Marine Fisheries Service Southwest Fisheries Science Center Santa Cruz, California
1994-1995	Statistical Consultant California Department of Fish and Game Ofc. of Oil Spill Prevention and Response Sacramento, California
1994	Visiting Assistant Professor Humboldt State University Departments of Mathematics and Fisheries Arcata, California

**RESEARCH INTERESTS:** Estimator development, population dynamics, stock assessment, fishery management under uncertainty.

**HONORS AND AWARDS:** Bronze Medal, DOC, 2002; Employee of the Year, NMFS, 2001; Special Service Award, NMFS, 2001; Special Act, NMFS, 2001; Outstanding Performance Award, NMFS, 1999; Special Act, NMFS, 1999; Special Act, NMFS, 1999; High Level of Performance, NMFS, 1997.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Fishery Management Plan Amendment Group, Central Valley Chinook, Pacific Fishery Management Council, 2002-present; Salmon Technical Team, Pacific Fishery Management Council, 1997-present; Klamath River Technical Advisory Team, Klamath Fishery Management Council, 1997-present; Coho Salmon Biological Review Team, NMFS, 1996-1997; Mass Mark Working Group, NMFS, 1996-1997.

### SELECTED PUBLICATIONS:

Lindley, Steven, T., and Michael S. Mohr. *In Press*. Predicting the impact of striped bass (*Morone saxatilis*) population manipulations on the persistence of winter-run chinook salmon (*Oncorhynchus tshawytscha*). Fishery Bulletin.

Grover, Allen M., Michael S. Mohr, and Melodie L. Palmer-Zwahlen. 2002. Hook-and-release mortality of chinook salmon from drift mooching with circle hooks: management implications for California's ocean sport fishery. Pages 39-56 in J. A. Lucy and A. L. Studholme, editors. Catch and release in marine recreational fisheries. American Fisheries Society, Symposium 30, Bethesda, Maryland.

Prager, Michael H., and Michael S. Mohr. 2001. The harvest rate model for Klamath River fall chinook salmon, with management applications and comments on model development and documentation. North American Journal of Fisheries Management 21:533-547.

Norton, E. C., R. B. MacFarlane, and M. S. Mohr. 2001. Lipid class dynamics during development in early life stages of shortbelly rockfish and their application to condition assessment. Journal of Fish Biology 58:1010-1024.

Lindley, Steven, T., Michael S. Mohr, and Michael H. Prager. 2000. Monitoring protocol for Sacramento River winter chinook salmon, *Oncorhynchus tshawytscha*: application of statistical power analysis to recovery of an endangered species. Fishery Bulletin 98:759-766.

## CURRICULUM VITAE

**NAME:** ELIZABETH C. NORTON

**PRESENT POSITION:** Research Fishery Biologist, Salmon Ecology Team

**EDUCATION:** B.A., Aquatic Biology, University of California, Santa Barbara, 1983.

<b>PAST EXPERIENCE:</b>	1990-present	Research Fishery Biologist NMFS Santa Cruz and Tiburon, California
	1987-1990	Biological Technician NMFS Tiburon, California
	1985-1987	Educational Sales Representative, Portland, Oregon
	1984	Foreign Fisheries Observer - 3 Bering Sea Tours NMFS Seattle, Washington

**RESEARCH INTERESTS:** Salmon feeding ecology, zooplankton ecology, larval fish condition.

**VOLUNTEER ACTIVITIES:** Docent, California Academy of Sciences, San Francisco, CA 1992-1996; Lecturer, "Expanding Your Horizons," Skyline College, San Bruno, CA 1990, 1992; Discovery Day, Romberg Tiburon Center for Environmental Studies, San Francisco State University, Tiburon, CA 1989-1996; UCSB Research Assistant, Scripps Institute of Oceanography, CALCOFI and NMFS research cruises, 1983.

**HONORS AND AWARDS:** Chancellor's Scholar, UCSB, 1979; NOAA Performance Awards, 1993, 1994, 1995, 1996, 2000.

**SELECTED SERVICE ON COMMITTEES:** Southwest Region Equal Employment Opportunity Advisory Committee, Personnel Subcommittee Chair, 2000-2002.

### SELECTED PUBLICATIONS:

Eldridge, M. B., E. C. Norton\*, B. M. Jarvis, and R. B. MacFarlane. In press. Energetics of early development in the viviparous yellowtail rockfish. *Journal of Fish Biology*.

Norton, E. C., R. B. MacFarlane, and M. S. Mohr. 2001. Lipid class dynamics during development in early life stages of shortbelly rockfish (*Sebastes jordani*) and their application to condition assessment. *J. Fish Biol.* 58, 1010-1024.

MacFarlane, R. B., and E. C. Norton. 2002. Physiological ecology of juvenile chinook salmon (*Onchorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. *Fish. Bull.*, U.S. 100:244-257.

Norton, E. C., and R. B. MacFarlane. 1999. Lipid class composition of the viviparous yellowtail rockfish (*Sebastes flavidus*) over the reproductive cycle. *J. Fish Biol.* 54:1287-1299.

MacFarlane, R. B., and E. C. Norton. 1999. Nutritional dynamics during embryonic development in the viviparous genus *Sebastes* and their application to the assessment of reproductive success. *Fish. Bull.*, U.S. 97:273-281.

MacFarlane, R. B., and E. C. Norton. 1996. Lipid and protein changes during embryo development in the viviparous genus *Sebastes*: Application to the assessment of reproductive success. In Don MacKinlay and Maxwell Eldridge (eds.), *The fish egg: Its biology and culture*, p. 95-102. International Congress on the Biology of Fishes, American Fisheries Society, Physiology Section, San Francisco State University, July 14-18, 1996.

Norton, E. C., and R. B. MacFarlane. 1995. Nutritional dynamics of reproduction in viviparous yellowtail rockfish (*Sebastes flavidus*). *Fish. Bull.*, U.S. 93:299-307.

## CURRICULUM VITAE

**NAME: DONALD E. PEARSON**

**PRESENT POSITION:** Fishery Biologist, Groundfish Population Analysis Team

**EDUCATION:** M.S., Biology, University of the Pacific, 1985; B.S., Ecology, San Jose State University, 1980.

**PAST EXPERIENCE:**

1987-present	Fishery Biologist, Fishery Technician NMFS/ SWFSC Santa Cruz and Tiburon Laboratories
1986-1987	Biological Technician California Department of Fish and Game Menlo Park, California
1983-1985	Graduate Assistant University of the Pacific Stockton, California
1979-1981	Biologist Marine Ecological Institute Redwood City, California

**RESEARCH INTERESTS:** Stock assessment, estuarine biology, and population ecology.

**HONORS AND AWARDS:** NOAA Certificates of Recognition, 1993, 1994; NOAA Sustained Outstanding Performance Award, 1990; Honorable Mention Best Publication, Fisheries Bulletin, 1989; NOAA Special Achievement Award, 1987.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Groundfish Management Team member, 1991-1993; Applications Target Architecture Team member, 1997-1998, NMFS coordinator for California Cooperative Survey.

### SELECTED PUBLICATIONS:

Pearson, Donald E. Data availability, landings, and length trends of California's rockfish. U.S. Dept. Comm. Admin. Rpt. SC-00-01. March 2000. 94pp.

Pearson, Donald E., and Brenda Erwin. 1997. Documentation of California's commercial market sampling data entry and expansion programs. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-240, 62 p.

Pearson, Donald E. 1996. Timing of hyaline-zone formation as related to sex, location, and year of capture in otoliths of the widow rockfish *Sebastes entomelas*. Fish. Bull., U.S. 94:190-197.

Pearson, Donald E. 1994. An initial examination of the status of the bank rockfish fishery off the coast of California. Appendix E. In Status of the Pacific Coast Groundfish Fishery through 1994 and recommended acceptable biological catches for 1995. Pacific Fishery Management Council, Portland, Oregon.

Pearson, Donald E., David A. Douglas, and Bill Barss. 1993. Biological observations from the Cobb Seamount rockfish fishery. Fish. Bull., U. S. 91(3):573-576.

Pearson, Donald E., and Joseph E. Hightower. 1991. Spatial and temporal variability in growth of widow rockfish (*Sebastes entomelas*). U. S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-167, 43 p.

Pearson, Donald E., Joseph E. Hightower and Jacqueline T. H. Chan. 1991. Age, growth, and potential yield for shortbelly rockfish *Sebastes jordani*. Fish. Bull., U. S. 89(3):403-409.

## CURRICULUM VITAE

**NAME: KERRIE A. PIPAL**

**PRESENT POSITION:** Laboratory Assistant II (Research Fishery Biologist)

**EDUCATION:** M.S., Natural Resources Management, Fisheries Biology, Humboldt State University, Arcata, CA, Expected 2003; B.S., Biological Sciences, Marine Biology, California Polytechnic State University, San Luis Obispo, CA, 1993.

**PAST EXPERIENCE:**

2002 - Present	Research Fishery Biologist/Laboratory Assistant National Marine Fisheries Service Santa Cruz, California
1998 - 2001	Senior Clinical Data Coordinator Quintiles Pacific, Inc. Mountain View, California
1995 - 1997	Naturalist and Lead Kayaking Guide Seaquest Expeditions and Zoetic Research Friday Harbor, San Juan Island, Washington
1994 - 1995	Nature Discovery Center Intern The Conservancy, Inc. Naples, Florida
1993 - 1994	Marine Biology Instructor Catalina Island Marine Institute Two Harbors, Catalina Island, California

**RESEARCH INTERESTS:** Salmon ecology and life history; field survey methodology; data analysis.

**HONORS AND AWARDS:** Humboldt State University, Arcata, CA, Marin Rod and Gun Club Scholarship Award.

**PROFESSIONAL AFFILIATIONS:** American Fisheries Society

## CURRICULUM VITAE

**NAME:** STEPHEN VAN DYKE RALSTON

**PRESENT POSITION:** Research Fishery Biologist, Groundfish Population Analysis Team

**EDUCATION:** Ph.D., Fisheries, University of Washington, Seattle, 1981; M.S., Zoology, University of Hawaii, Honolulu, 1975; B.A., Zoology, University of California, Los Angeles, 1971.

**PAST EXPERIENCE:**

1988-present	Research Fisheries Biologist NMFS/SWFSC Santa Cruz and Tiburon California
1986-1988	Task Leader, Insular Stock-Assessment NMFS/SWFSC Honolulu, Hawaii
1978-1982	Fishery Biologist Fisheries Research Institute, University of Washington Seattle, Washington

**RESEARCH INTERESTS:** Fisheries population dynamics, stock assessment, age and growth of fishes, recruitment processes, fishery oceanography.

**HONORS AND AWARDS:** Honolulu Laboratory Nominee for Manager of the Year, 1986; NMFS Publications Advisory Committee Honorable Mention for best publication in U.S. Fishery Bulletin, 1984, 1985, 1986.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Scientific and Statistical Committee, Pacific Fishery Management Council, 1999-present; Groundfish Management Team, Pacific Fishery Management Council, 1995-1997; External Examiner on Ph.D. Dissertation of Mr. Stephen J. Newman, University of North Queensland, Australia, 1995; Master's Thesis Committee, U.S. Naval Postgraduate School, Monterey, California, 1998; Master's Thesis Committees, California State University, San Francisco, 1991, 1992, 1996, 1998-present; Master's and Doctoral Thesis Committees, University of Hawaii, Honolulu, 1984-1986, 1989; Bottomfish/Seamount Plan Development and Monitoring Teams, Western Pacific Fishery Management Council, 1979-1988.

### SELECTED PUBLICATIONS:

Ralston, S., W. H. Lenarz, and D. P. Woodbury. In prep. Long-term variability in year-class strength of northern California rockfishes (*Sebastes* spp.) in relation to the larval ocean environment and young-of-the-year growth. Fish. Oceanogr.

Ralston, S., J. R. Bence, M. B. Eldridge, and W. H. Lenarz. In review. An approach to estimating the spawning biomass of rockfish using a larval production method with application to *Sebastes jordani*. Fishery Bulletin.

Williams, E. H., and S. Ralston. In press. Distribution and co-occurrence of rockfishes (Family Scorpaenidae) over trawlable shelf and slope habitats of California and southern Oregon. Fish. Bull. 100(4).

Ralston, S. 2002. The west coast groundfish harvest policy workshop. N. Amer. J. Fish. Management. 22:249-250.

MacCall, A. D., and S. Ralston. 2002. Is logarithmic transformation *really* the best procedure for estimating stock-recruitment relationships? N. Amer. J. Fish. Management. 22:339-350.

Ralston, S., and W. H. Lenarz. 2001. Widow Rockfish. In: California's Living Marine Resources: a Status Report. W. S. Leet, et al. (eds.). California Department of Fish and Game, pp. 370-371.

Rau, G. H., S. Ralston, J. R. Southon, and F. P. Chavez. 2001. Upwelling and the condition and diet of juvenile rockfish: a study using <sup>14</sup>C, <sup>13</sup>C, and <sup>15</sup>N natural abundances. Limnol. Oceanogr. 46(6):1565-1569.

## CURRICULUM VITAE

**NAME: KEITH M. SAKUMA**

**PRESENT POSITION:** Research Fishery Biologist, Groundfish Population Analysis Team

**EDUCATION:** M.A., Marine Biology, San Francisco State University, 1992; B.A., Zoology, University of Hawaii, Manoa, 1987.

**PAST EXPERIENCE:**

1992-present	Research Fishery Biologist NMFS/SWFSC Santa Cruz and Tiburon, California
1991-1992	Student Trainee in Biological Sciences NMFS/SWFSC Tiburon, California
1989-1992	Teaching Assistant/Graduate Assistant San Francisco State University San Francisco, California
1985-1989	Fishery Aide State of Hawaii Division of Aquatic Resources Honolulu, Hawaii

**RESEARCH INTERESTS:** Fisheries oceanography, age and growth of larval and juvenile fish, larval fish taxonomy, and population dynamics.

**HONORS AND AWARDS:** Outstanding Performance Rating, 1993, 1995, 1997.

### SELECTED PUBLICATIONS:

Sakuma, K.M., F.B. Schwing, M.H. Pickett, D. Roberts, and S. Ralston. 2001. The physical oceanography off the central California coast during May-June, 1999: a summary of CTD data from pelagic juvenile rockfish surveys. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-315, 86 pp.

Sakuma, K.M., S. Ralston, and D.A. Roberts. 1999. Diel vertical distribution of post-flexion larval *Citharichthys* spp. and *Sebastes* spp. off central California. Fisheries Oceanogr. 8:68-76.

Sakuma, K.M., S. Ralston, W.H. Lenarz, and M. Embury. 1999. Effects of the parasitic copepod *Cardiodectes Medusaeus* on the lanternfishes *Diaphus theta* and *Tarletonbeania crenularis* off central California. Environ. Biol. Fishes 55:423-430.

Sakuma, K.M., and S. Ralston. 1997. Vertical and horizontal distribution of juvenile Pacific whiting (*Merluccius productus*) in relation to hydrography off California. Calif. Coop. Oceanic Fish. Invest. Rep. 38:137-146.

Sakuma, Keith M., and Thomas E. Laidig. 1995. Description of larval and pelagic juvenile chilipepper, *Sebastes goodei* (family Scorpaenidae), with an examination of larval growth. Fish. Bull. 93:721-731.

Sakuma, Keith M., and Stephen Ralston. 1995. Distributional patterns of late larval groundfish off central California in relation to hydrographic features during 1992 and 1993. Calif. Coop. Oceanic Fish. Invest. Rep. 36:179-192.

Sakuma, Keith M., and Ralph J. Larson. 1995. Distribution of pelagic metamorphic-stage sanddabs *Citharichthys sordidus* and *C. stigmaeus* within areas of upwelling off central California. Fish. Bull. 93:516-529.

## CURRICULUM VITAE

**NAME: ROBERT S. SCHICK**

**PRESENT POSITION:** Research Associate, Salmon Population Analysis Team

**EDUCATION:** M.E.M., Resource Ecology, Duke University, 2002; B.S., Zoology, University of Washington, 1997.

**PAST EXPERIENCE:**

2002-present	Research Associate NOAA Fisheries, Southwest Fisheries Science Center Santa Cruz, California
2000-2002	Assistant Scientist/GIS New England Aquarium/Edgerton Research Lab Boston, Massachusetts

**RESEARCH INTERESTS:** Spatial dynamics of species in relation to environmental parameters. Quantifying empirical relationships between marine species and measurable oceanographic parameters. Application of GIS & Remote Sensing to Ecological research. Connectivity in threatened populations. Numerical Ecology. Landscape Ecology.

**HONORS AND AWARDS:** Merit Scholarship, Nicholas School of the Environment, Duke University, 1998; Environmental Internship Fund Fellow, Duke University, Summer 1999; Dean's list, University of Washington.

### SELECTED PUBLICATIONS:

Schick, R.S. 2002. Using GIS to Track Right Whales and Bluefin Tuna in the Atlantic Ocean. In *Undersea with GIS*, D.J. Wright (ed.), ESRI Press Redlands, CA.

Schick, R.S. 2001. Tuna distribution in relation to physical features in the Gulf of Maine. In *Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism*, C. Convis (ed.), ESRI Press Redlands, CA.

Schick, R.S. and D.L. Urban. 2000. Spatial components of bowhead whale (*Balaena mysticetus*) distribution in the Alaskan Beaufort Sea. *Can. J. Fish. Aq. Sci.* 57: 2193-2200.

## CURRICULUM VITAE

**NAME: SUSAN M. SOGARD**

**PRESENT POSITION:** Ecology Branch Chief

**EDUCATION:** Ph.D. in ecology, October 1990, Rutgers University, New Brunswick, New Jersey; M.S. in marine biology, July 1982, University of Miami, Miami, Florida; B.S. (cum laude) in zoology and psychology, May 1977.

**PAST EXPERIENCE:**

2001-present	Supervisory Research Fishery Biologist NMFS/NOAA/SWFSC Santa Cruz, CA
1993-2001	Oceanographer NMFS/NOAA/AFSC Newport, OR
1984-1987	Research Biologist National Audubon Society Tavernier, FL

**RESEARCH INTERESTS:** Behavioral and population ecology of marine organisms, population dynamics and recruitment variability of early life history stages, costs of growth in juvenile fishes, life history strategies.

**HONORS AND AWARDS:** NOAA Special Service Award, 1999, 2000; Stoye Award, best student paper, ASIH meeting, 1990; J. Frances Allen Scholarship, American Fisheries Society, 1990.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Science Advisory Group of the Interagency Ecological Program on San Francisco Bay fisheries research (1999-2002); Higher Trophic Level Initiative, Florida Bay Research Program (1997); National Undersea Research Program Panel (1996); National Sea Grant Fisheries Panel (1993); EPA Global Climate Change Program (1992).

### SELECTED PUBLICATIONS:

Sogard, S.M. and B.L. Olla. (in press). Contrasts in the capacity for compensatory growth and underlying mechanisms in two pelagic marine fishes. *Mar. Ecol. Prog. Ser.*

Sogard, S.M. and B.L. Olla. 2001. Growth and behavioral responses to elevated temperatures by juvenile sablefish (*Anoplopoma fimbria*) and the interactive role of food availability. *Mar. Ecol. Prog. Ser.* 217: 121-134.

Sogard, S.M., K.W. Able and S.M. Hagan. 2001. Long-term assessment of settlement and growth of juvenile winter flounder (*Pseudopleuronectes americanus*) in New Jersey estuaries. *J. Sea Res.* 45:189-204.

Sogard, S.M. and B.L. Olla. 2000. Effects of group membership and size distribution within a group on growth rates of juvenile sablefish *Anoplopoma fimbria*. *Env. Biol. Fishes* 59:199-209.

Sogard, S.M. and B.L. Olla. 2000. Endurance of simulated winter conditions by age-0 walleye pollock (*Theragra chalcogramma*): effects of body size, water temperature and energy stores. *J. Fish Biol.* 56:1-21.

Matheson, R.E. Jr., D.A. Camp, S.M. Sogard, and K.A. Bjorgo. 1999. Changes in seagrass-associated fish and crustacean communities on Florida Bay mud banks: the effects of recent ecosystem changes? *Estuaries* 22:534-551.

Sogard, S.M. and B.L. Olla. 1998. Contrasting behavioral responses to cold temperatures by two marine fish species during their pelagic juvenile interval. *Env. Biol. Fish.* 53:405-412.

Sogard, S.M. and B.L. Olla. 1998. Behavior of juvenile sablefish, *Anoplopoma fimbria* (Pallas), in a thermal gradient: Balancing food and temperature requirements. *J. Exp. Mar. Biol. Ecol.* 222:43-58.

## CURRICULUM VITAE

**NAME: BRIAN C. SPENCE**

**PRESENT POSITION:** Research Fishery Biologist, Salmon Population Analysis Team

**EDUCATION:** Ph.D., Fisheries Science, Oregon State University, 1995; M.S., Natural Resources (Fishery Science), Cornell University, 1989; B.S., Wildlife and Fisheries Biology, University of California, Davis, 1983.

**PAST EXPERIENCE:**

2000-present	Research Fishery Biologist National Marine Fisheries Service Santa Cruz, California
1998-2000	Visiting Faculty, Environmental Studies The Evergreen State College, Olympia, Washington
1996-1997	Consultant, Aquatic Ecologist Umpqua Land Exchange Project Corvallis, Oregon
1995-1996	Project Scientist, Fisheries ManTech Environmental Research Services Corporation Corvallis, Oregon
1990-1995	Graduate Research/Teaching Assistant Department of Fisheries and Wildlife Oregon State University, Corvallis, Oregon

**RESEARCH INTERESTS:** Life-history variation in Pacific salmonids; salmonid habitat relationships; effects of human perturbations on aquatic ecosystems; conservation biology of resident and anadromous fishes.

**PROFESSIONAL AFFILIATIONS:** American Fisheries Society; Society for Conservation Biology.

**SERVICE ON SCIENTIFIC COMMITTEES:** Current member of Technical Recovery Team for listed salmonids in the North Central California Coast Domain.

### PUBLICATIONS:

Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and P. B. Adams. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Hobbs, S. H., R. L. Beschta, E. D. Clark, W. Dennison, J. Gabriel, S. Garman, R. Gill, S. Gregory, R. Jones, W. McComb, A. McKee, K. Pollett, W. Ripple, J. Sessions, B. C. Spence, D. Vesely, and D. Wagner. 1998. Pilot study report: Umpqua Land Exchange Project. World Forestry Center, Portland, OR. 170 p. + appendices.

Spence, B. C., G. A. Lomnický, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corporation, Corvallis, OR. 356 p.

Spence, B. C. 1995. Geographic variation in timing of fry emergence and smolt migration in coho salmon (*Oncorhynchus kisutch*). Ph.D. thesis, Oregon State University, Corvallis, OR. 201 p.

Gucinski, H., R. T. Lackey, and B. C. Spence. 1991. Global climate change: Policy implications for fisheries. Fisheries 15(6):33-38.

Spence, B. C. 1989. Effects of temperature, food availability and social dominance on microhabitat selection by steelhead and rainbow trout (*Oncorhynchus mykiss*). M.S. thesis, Cornell University, Ithaca, NY. 83 p.



## CURRICULUM VITAE

**NAME: R. GLENN SZERLONG**

**PRESENT POSITION:** Staff Research Associate III, Analytic Support, Salmon Population Analysis Team

**EDUCATION:** M.Sc. (In progress) Statistics, University of Idaho; B.Sc. Fisheries Biology, Colorado State University

**PAST EXPERIENCE:**

2002-present	Research Associate NOAA Fisheries, Southwest Fisheries Science Center Santa Cruz, California
1999-2001	Graduate Research Assistant Division of Statistics University of Idaho Moscow, Idaho
	Statistical Consultant Nez Perce Tribe – Fisheries Research Idaho
1998-1999	Fisheries Biologist Nez Perce Tribe – Fisheries Research Oregon
1996-1998	Fisheries Technician Columbia River Inter-Tribal Fisheries Commission Oregon

**RESEARCH INTERESTS:** Population dynamics, stochastic processes, theoretical ecology, statistical ecology.

**HONORS AND AWARDS:** Dale Hein Award for Student Excellence.

## CURRICULUM VITAE

**NAME:** CYNTHIA J. THOMSON

**PRESENT POSITION:** Economics Team Leader, Fisheries Branch

**EDUCATION:** M.A., Economics, University of California, San Diego, 1977; B.A., Sociology, University of California, San Diego, 1972.

<b>PAST EXPERIENCE:</b>	1996-present	Economist NMFS/SWFSC Santa Cruz, California
	1978-1996	Economist NMFS/SWFSC La Jolla, California
	1975-1977	Teaching Assistant, Department of Economics University of California, San Diego La Jolla, California
	1974	Research Assistant - Sea Grant Project

**RESEARCH INTERESTS:** Fishery management, non-market valuation, salmon habitat restoration cost estimation, design of fishery economic surveys, economics of marine protected areas.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Pacific Fishery Management Council, Scientific and Statistical Committee, 1991-present, vice chair 1998-1999, chair 2000-2001; Chair, SSC Marine Reserve Subcommittee, 2001-present; RecFIN Committee, 1996-present; State of California Squid Research Scientific Committee, 1999-2001; NOAA Superfund Litigation Team, 1993-1996; Pacific Fishery Management Council, Coastal Pelagics Plan Development Team, 1991-1994; Pacific Fishery Management Council, Anchovy Plan Development Team, 1989-1991.

### SELECTED PUBLICATIONS:

Thomson, C.J. In review. Conclusions and Recommendations. In: Allen, S. *et al.* (eds.) Proceedings of the Salmon Habitat Restoration Cost Workshop. Pacific States Marine Fisheries Commission, Portland, OR.

Thomson, C.J. 2001. The human ecosystem. In: Leet, W. *et al.* (eds.). *California's Living Marine Resources: A Status Report*. California Department of Fish and Game.

Thomson, C.J. *et al.* 2000. *Overcapitalization in the West Coast Groundfish Fishery: Background, Issues and Solutions*. Prepared for the Pacific Fishery Management Council by the Scientific and Statistical Committee, Economics Subcommittee. 116 p.

Thomson, C.J. 1999. Economic and implications of no-take reserves: an application to *sebastes* rockfish in California. *Calif. Coop. Oceanic Fish. Invest. Rep.* 40:107-117.

Thomson, C. 1998. Evaluating marine harvest refugia: an economic perspective. In: Yoklavich, Mary (ed.). *Marine Harvest Refugia for West Coast Rockfish: A Workshop*. U.S. Dep. Commer., NOAA Tech Memo, NOAA-TM-NMFS-SWFSC-255.

Thomson, C. 1997. Analysis of agency costs attributable to the Recovery Plan for Sacramento River winter-run chinook salmon. U.S. Dep. Commer., NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-249.

Kling, C.L. and C.J. Thomson. 1996. The implications of model specification for welfare estimation in nested logit models. *American Journal of Agricultural Economics*. 78:103-114.

## CURRICULUM VITAE

**NAME: DAVID TOMBERLIN**

**PRESENT POSITION:** Economist, Fisheries Branch

**EDUCATION:** Ph.D., Forest Economics, University of Wisconsin - Madison, 1999; M.S., Agricultural and Resource Economics, North Carolina State University, 1993; B.A., English and Creative Writing, Princeton University, 1988.

<b>PAST EXPERIENCE:</b>	1999-present	Economist NMFS/ SWFSC Santa Cruz, California
	1993-1999	Research Assistant Department of Forestry, University of Wisconsin
	1998	Economics Consultant Food and Agriculture Organization, Rome, Italy
	1992-1993	Research Assistant North Carolina State University, Raleigh, North Carolina
	1988-1990	Lecturer Universitas Bung Hatta, Padang, Indonesia

**RESEARCH INTERESTS:** Resource management under uncertainty, real options analysis in public policy, commercial fishing fleet dynamics, fish/forestry interactions

**HONORS AND AWARDS:** McGovern Scholar, 1997, 1998; USDA National Research Initiative grantee, 1994, 1998; Center for Southeast Asian Studies Fellow, 1995; Magna Cum Laude, Phi Beta Kappa, Croll Prize, 1988

### SELECTED PUBLICATIONS:

Tomberlin, D. "Modeling California Salmon Fleet Dynamics." In Proceedings of the 2001 North American Association of Fisheries Economists meeting, April 2-4. Forthcoming.

Tomberlin, D. "The Allocation Problem in Habitat Restoration." In Proceedings of the Habitat Restoration Cost workshop, Gladstone, OR, October 2000. December 2001.

Tomberlin, D., and J. Buongiorno. "Timber Plantations, Timber Supply, and Forest Conservation." In Mati Palo, ed., World Forests, Markets, and Policies. Kluwer Academic Publishers. .

Tomberlin, D. "Real Options Analysis of Entry and Exit in Fisheries." Presented to the NMFS economists' national meeting, La Jolla, February 2000.

Tomberlin, D., J. Buongiorno, and D. Brooks. "Trade, Forestry, and the Environment: Issues and Methods." *Journal of Forest Economics* 4(3):177-206. Fall 1998.

Tomberlin, D., J. Buongiorno, and S. Zhu. "ASIAPAC: A Model of Consumption, Production, and Trade in the Asia-Pacific Forest Sector." *FAO Forest Sector Background Paper*. 1998.

## CURRICULUM VITAE

**NAME: THOMAS H. WILLIAMS**

**PRESENT POSITION:** Research Fishery Biologist, Salmon Population Analysis Team

**EDUCATION:** Ph.D. candidate, Fisheries Science, Oregon State University; M.S., Fish and Wildlife Management, Montana State University, Bozeman, 1990; B.S., Fisheries, Humboldt State University, 1985.

**PAST EXPERIENCE:**

1998 - present	Research Fishery Biologist, NMFS Santa Cruz, California
1992 - 1998	Graduate Research/Teaching Assistant Department of Fisheries and Wildlife Oregon State University, Corvallis, Oregon
1991 - 1992	Research Assistant, Oregon Cooperative Wildlife Research Unit Staff member - Northern Spotted Owl Recovery Team Oregon State University, Corvallis, Oregon

**RESEARCH INTERESTS:** Ecology of Pacific salmonids and relations among marine, freshwater, and terrestrial communities; conservation biology and conservation genetics related to conservation of Pacific salmon and trout.

**PROFESSIONAL AFFILIATIONS:** American Fisheries Society, Ecological Society of America, Gilbert Ichthyological Society, The Wildlife Society

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Member of technical panel for NMFS workshop on Assessing Extinction Risk for West Coast Salmonids, Seattle, 1996; Biological Review Team, Coastal Cutthroat Trout 1998; Biological Review Team, Klamath Mountains Province Steelhead 2001; Chairman, Technical Recovery Team, Southern Oregon/Northern California Recovery Domain, present.

### SELECTED PUBLICATIONS:

Williams, T. H., and G. H. Reeves. (In Press). Ecological diversity and risk of extinction of Pacific salmon and trout. NOAA-NMFS Technical Memorandum XXXXX.

Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and P. B. Adams. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Williams, T. H., and G. H. Reeves. 2001. Identification and conservation considerations of hybrids between coastal cutthroat trout and steelhead trout. Pages 259-260 in M. K. Brewin, A. J. Paul, and M. Monita, editors. Bull trout II conference proceedings. Trout Unlimited Canada, Calgary, Alberta.

Currens, K. P., F. W. Allendorf, D. Bayles, D. L. Bottom, C. A. Frissell, D. Hankin, J. A. Lichatowich, P. C. Trotter, and T. H. Williams. 1998. Conservation of Pacific Salmon: response to Wainwright and Waples. *Conservation Biology* 12(5):1148-1149.

Williams, T. H., K. P. Currens, N. E. Ward III, and G. H. Reeves. 1997. Genetic population structure of coastal cutthroat trout. Pages 16-17 in J. D. Hall, P. A. Bisson, and R. G. Gresswell, editors. *Sea-run cutthroat trout: biology, management, and future conservation*. Oregon Chapter, American Fisheries Society, Corvallis, OR.

Allendorf, F. W., D. Bayles, D. L. Bottom, K. P. Currens, C. A. Frissell, D. Hankin, J. A. Lichatowich, W. Nehlsen, P. C. Trotter, and T. H. Williams. 1997. Prioritizing Pacific salmon stocks for conservation. *Conservation Biology* 11:140-152.

## CURRICULUM VITAE

**NAME:** LISA M. WOONINCK

**PRESENT POSITION:** Research Fishery Biologist, Habitat Ecology Team

**EDUCATION:** Ph.D. candidate, Ecology, Evolution & Marine Biology, University of California, Santa Barbara; M.S. with distinction, Biology, California State University, Northridge, 1993; B.A., Biology with an emphasis in Aquatic Biology, California State University, Northridge, 1990.

**PAST EXPERIENCE:** 2001 - present      Research Fishery Biologist, NMFS  
Santa Cruz, California

2000 - 2001      National Knauss Sea Grant Fellow  
Staff member of Congressman Farr  
Washington, DC

**RESEARCH INTERESTS:** Marine protected areas, reproductive ecology of fishes, population dynamics and recruitment processes.

**HONORS AND AWARDS:** National Sea Grant Knauss Fellowship, 2000; Smithsonian Predoctoral Fellowship, 1997; Raney Fund, American Society of Ichthyology and Herpetology, 1997; President's Year Fellowship, University of California, 1996; Smithsonian Graduate Student Fellowship, 1995; First Prize, Student Research Presentation, Sigma XI, CSUN, 1992

### SELECTED PUBLICATIONS:

Wooninck, L.M., R.R. Warner. (Submitted). Paternity and mechanisms of individual fertilization success in mixed-male phenotype matings of a coral reef fish.

Wooninck, L.M., R.R. Warner, and R.C. Fleischer. 2000. Relative fitness components measured with competitive PCR. *Molecular Ecology*, 9, 1409-1414.

Wooninck, L.M., R.C. Fleischer, and R.R. Warner. 1998. Characterization of microsatellite loci in a pelagic spawner: the bluehead wrasse, *Thalassoma bifasciatum*. *Molecular Ecology*, 7, 1613-1614.

Wooninck, L.M. and R.R. Warner (In Prep). Paternity in group spawns of a coral reef fish.

## CURRICULUM VITAE

**NAME: MARY M. YOKLAVICH**

**PRESENT POSITION:** Research Fishery Biologist, Habitat Ecology Team

**EDUCATION:** M.S., Marine Sciences, Moss Landing Marine Labs, San Francisco State University, 1982; B.A., Biological Sciences, University of California, Santa Barbara, 1973.

**PAST EXPERIENCE:**

1988-present	Research Fishery Biologist National Marine Fisheries Service Alaska Fisheries Science Center, Seattle (1988-89) Pacific Fisheries Environmental Laboratory, Pacific Grove (1991-99) SWFSC, Santa Cruz, California (1999-present)
1989-1991	Research Associate Moss Landing Marine Labs and Elkhorn Slough Foundation Moss Landing, California
1984-1988	Senior Research Assistant, Oregon State University College of Oceanic and Atmospheric Sciences Newport, Oregon

**RESEARCH INTERESTS:** Species - habitat associations, developing new technologies to study deepwater habitats, marine protected areas, larval and juvenile fish ecology, environmental effects on coastal marine fishes.

**HONORS AND AWARDS:** Distinguished Fellow in Science and Technology, California State University, Monterey Bay, 2000; Bronze Medal - Superior Federal Service, U.S. DOC, 1998; Nominee for Pew Fellows Program in Marine Conservation, 1998; NOAA Monterey Bay National Marine Sanctuary Science Award, 1998; NOAA Performance Awards, 1988, 1992-98.

**SELECTED SERVICE ON SCIENTIFIC COMMITTEES:** Advisor on NMFS EIS for Groundfish EFH, 2002; California Marine Life Protection Act Master Plan Team, 2000-present; PFMC, Advisory Committee on Marine Reserves, 1999-2001; NOAA-NMFS Protected Resources panel member for "Candidate Species", 1997-present; NOAA-NMFS Essential Groundfish Habitat Core Team, 1996-1999.

### SELECTED PUBLICATIONS:

Yoklavich, M., G. Cailliet, R.N. Lea, H.G. Green, R. Starr, J. deMarignac, and J. Field. (In Press) Deepwater habitat and fish resources associated with the Big Creek Ecological Reserve. CalCOFI Reports 43.

Yoklavich, M., G. Cailliet, D. Oxman, J.P. Barry, and D.C. Lindquist. (In Press) Fish assemblages of Elkhorn Slough and adjacent habitats. *In* Caffrey, J. (Ed.). Ecosystem Changes in a California Estuary: a Characterization of Elkhorn Slough.

Love, M.S., M. Yoklavich and L. Thorsteinson. (2002) The Rockfishes of the Northeast Pacific. University of California Press, 405 p.

Johnson, K.A., M.M. Yoklavich, and G.M. Cailliet. (2001) Recruitment of three species of juvenile rockfish (*Sebastes* spp.) on soft benthic habitats in Monterey Bay, California. CalCOFI Reports 42:153-166.

Yoklavich, M., H. G. Greene, G. Cailliet, D. Sullivan, R. Lea, and M. Love. (2000). Habitat associations of deep-water rockfishes in a submarine canyon: an example of a natural refuge. Fishery Bulletin, U.S. 98:625-641.

Yoklavich, M. (Ed.) (1998). Marine harvest refugia for west coast rockfish: A workshop. NOAA Technical Memorandum NMFS, NOAA-TM-NMFS-SWFSC-255. 159 p.(also now available online at [www.pfeg.noaa.gov](http://www.pfeg.noaa.gov)).

**APPENDIX B**

**PUBLICATIONS OF THE SANTA CRUZ LABORATORY**

**2000 - 2002**



## CURRENT MANUSCRIPTS

**Adams, P. B.**, W. M. Samiere, and C. J. Ryan.

In prep. Diet and prey switching of a marine predator, chinook salmon (*Oncorhynchus tshawytscha*) and their management implications.

Allen, L. G., **M. Yoklavich**, and G. Cailliet.

In prep. Bay and estuarine fishes. In: L. Allen, M. Horn, and D. Pondella (eds.), *Ecology of California Marine Fishes*.

Alonzo, J. J., and **R. B. MacFarlane**.

In prep. Smoltification in chinook salmon (*Oncorhynchus tshawytscha*) from California's central valley.

**Anderson, T. J.**

In prep. Spatial and temporal dynamics of a temperate seagrass bed (*Heterozostera tasmanica*): can spatio-temporal patterns in seagrass loss be used to determine process?

**Anderson, T. J.**, and C. Syms.

In prep. The role of spatio-temporal dynamics and habitat configuration in structuring fish assemblages in patchy seagrass landscapes.

**Anderson, T. J.**, and M. Keough.

In prep. Is fragmentation and seagrass cover important in maintaining fish diversity and abundance?

**Anderson, T. J.**, and M. Keough.

In prep. Temporal dynamics and ontogenetic shifts in habitat use of temperate seagrass fishes.

**Anderson, T. J.**, C. Syms, and M. Keough.

In prep. Temperate fishes in a patchy seagrass landscape: a spatially explicit approach.

**Bjorkstedt, E. P.**

In prep. Competition in common habitats: implications for the metapopulation dynamics of stage-structured species. *American Naturalist*.

**Bjorkstedt, E. P.**

In prep. Estimating population size in small populations using stratified mark-recapture techniques. *North American Journal of Fisheries Management*.

**Bjorkstedt, E.**

In prep. To swim or not to swim? Optimal strategies for pelagic life history and settlement of juvenile rockfish in a coastal upwelling system. *Marine Ecology Progress Series*.

**Bjorkstedt, E., and J. Roughgarden.**

In prep. A method for detecting fronts with solo high-frequency (HF) radar, with application in a coastal upwelling region. *Continental Shelf Research*.

**Bjorkstedt, E., B. Spence, C. Garza, et al. (North-Central Coast Technical Recovery Team).**

In prep. Independent populations in the California Coastal Evolutionarily Significant Unit of chinook salmon (*Oncorhynchus tshawytscha*): hypotheses and critical data gaps.

**Boughton, D. A.**

In prep. Limitations on using presence-absence data for detecting population turnover.

**Boughton, D. A., and H. Fish.**

In prep. Current distribution of steelhead (*Oncorhynchus mykiss*) in coastal streams of southern California.

**Boughton, D. A., and M. C. Singer.**

In review. Reproductive investment portfolios in a butterfly. *Ecology Letters*.

**Boughton, D. A., M. C. Wimberly, and T. A. Spies.**

In review. Disturbance regimes and the persistence of rare species in the Oregon Coast Range: a study of landscape stochasticity. *Ecological Modelling*.

**Brock, R., J. Bohnsack, M. Fogarty, S. Murawski, and M. Yoklavich.**

In prep. Marine fisheries of the United States: moving from single-species management to a more holistic ecosystem approach. [To be submitted to *Australian Society of Fish Biology*, Proceedings of the World Congress on Aquatic Protected Areas 2002.]

**Brodeur, R. D., W. G. Pearcy, and S. Ralston.**

In review. Abundance and distribution patterns of nekton and micronekton in the Northern California Current Transition Zone. *Journal of Oceanography*.

**Cai, D.**

In review. An extension of the classical estimates of dredge efficiency and fish stock abundance. *Natural Resource Modeling*.

Day, G. R., **C. B. Grimes**, and D. A. DeVries.

In prep. Distribution, abundance, growth and mortality of striped anchovy, *Anchoa hepsetus*, along environmental gradients associated with the Mississippi River discharge plume.

**Goslin, M. N.**, and T. A. Spies.

In prep. Fire history and post-fire establishment patterns in two coniferous forest stands, Cascade Mountains, Oregon. *Canadian Journal of Forest Research*.

**Grimes, C. B.**, and C. S. McNeil.

In prep. Diet and feeding ecology of striped anchovy, *Anchoa hepsetus*, along environmental gradients associated with the Mississippi River discharge plume.

**Grimes, C. B.**, and D. A. DeVries.

In prep. Growth and mortality of Spanish mackerel larvae along environmental gradients associated with the Mississippi River discharge plume.

Hankin, D. G., and **M. S. Mohr**.

In prep. Two-phase survey designs for estimation of fish abundance in small streams.

**Hayes, S. A.**, A. Kumar, D. P. Costa, D. K. Mellinger, J. T. Harvey, B. L. Southall, and B. J. Le Boeuf.

In review. Evaluating the function of male vocalizations in the harbor seal (*Phoca vitulina*) through playback experiments. *Animal Behavior*.

Isely, J. J., **C. B. Grimes**, and A. W. David.

In prep. Identification of hatchery-reared and wild red drum, *Sciaenops ocellatus*, using discriminant analysis of otolith banding patterns.

**Johnson, R. C.**, and **R. B. MacFarlane**.

In prep. Estuary use and growth history of juvenile Chinook salmon from the California Central Valley juvenile in the San Francisco Bay Estuary.

**Johnson, R. C., C. B. Grimes, and C. F. Royer.**

In prep. Discrimination of hatchery and wild chinook salmon (*Onchorhynchus tshawytscha*) in the California Central Valley using otolith microstructure.

**Laidig, T. E., D. E. Pearson, and L. L. Sinclair.**

In prep. Age and growth of blue rockfish (*Sebastes mystinus*) from central and northern California.

**Laidig, T. E., K. M. Sakuma, and J. A. Stannard.**

In prep. Description and growth of larval and pelagic juvenile *Sebastes wilsoni*, pygmy rockfish (Family Scorpaenidae).

**Lindley, S. T.**

In review. Estimating population growth and extinction parameters from noisy data. Ecological Applications.

**MacCall, A. D., and T. C. Wainwright (editors).**

In prep. Assessing extinction risk for West Coast salmon: Proceeding of the workshop. NOAA Technical Memorandum NMFS-NWFSC.

**MacFarlane, R. B., S. Ralston, C. Royer, and E. C. Norton.**

In prep. Effect of El Nino on growth of juvenile chinook salmon in the coastal waters of California.

**Norton, E. C., and R. B. MacFarlane.**

In prep. Feeding habits of juvenile salmon (*Onchorhynchus tshawytscha*) in the San Francisco Estuary.

**Norton, E. C., and R. B. MacFarlane.**

In prep. Interannual variability of juvenile shortbelly rockfish lipids in relation to environmental conditions off the California coast.

**Pearson, D. E., and F. R. Shaw.**

In review. Sources of age determination errors for sablefish (*Anoplopoma fimbria*). Fishery Bulletin.

**Ralston, S., W. H. Lenarz, and D. P. Woodbury.**

In prep. Long-term variability in year-class strength of northern California rockfishes (*Sebastes* spp.) in relation to the larval ocean environment and young-of-the-year growth. Fisheries Oceanography.

Reynolds, J. A., **S. Ralston**, and T. M. Powell.

In review. Temporal stability of the association between widow rockfish (*Sebastes entomelas*) and bottom depth.

Reynolds, J. A., T. M. Powell, and **S. Ralston**.

In review. Significant habitat associations for widow rockfish (*Sebastes entomelas*).

**Schick, R. S.**, J. Goldstein, and M. E. Lutcavage.

In review. Bluefin tuna (*Thunnus thynnus*) distribution in relation to sea surface temperature fronts in the Gulf of Maine (1993-1996). *Fisheries Oceanography*.

**Sogard, S. M.**, and M. L. Spencer.

Submitted. Patterns of energy allocation in juvenile sablefish: effects of temperature, ration, and body size. *Journal of Fish Biology*.

**Thomson, C.**

In review. Conclusions and recommendations. In: Stan Allen, Robin Carlson, and Cynthia Thomson (eds.), *Proceedings of the Salmon Habitat Restoration Cost Workshop*.

**Tomberlin, D.**

In prep. Exit decisions and latent capacity in a limited-entry fishery: the case of California salmon.

**Tomberlin, D.**

In prep. Road maintenance and salmonid habitat quality: an analytical approach.

Wahle, C., D. Brumbaugh, **M. Yoklavich**, M. Carr, et al.

In prep. Incremental phasing-in of networks of marine protected areas: matching policy expectations with ecological reality. [Invited to submit to Science's Policy Forum.]

## LIST OF PUBLICATIONS BY YEAR

### PUBLICATIONS - IN PRESS

**Bjorkstedt, E. P.**, L. K. Rosenfeld, B. A. Grantham, Y. Shkedy, and J. Roughgarden.

In press. Distributions of larval rockfish (*Sebastes* spp.) across nearshore fronts in a coastal upwelling region. Marine Ecology Progress Series.

**Eldridge, M. B.**, **E. C. Norton\***, **B. M. Jarvis**, and **R. B. MacFarlane**.

In press. Energetics of early development in the viviparous yellowtail rockfish. Journal of Fish Biology.

Gieger, S. P., J. J. Tores, and **C. B. Grimes**.

In press. Measures of physiological condition in larval anchovies, *Anchoa hepsetus*, collected in the discharge plume of the Mississippi River during the flood of 1993. Marine Ecology Progress Series.

**Lindley, S. T.**, and **M. S. Mohr**.

In press. Predicting the impact of striped bass (*Morone saxatilis*) population manipulations on the persistence of winter-run chinook salmon (*Oncorhynchus tshawytscha*). Fishery Bulletin

**Ralston, S.**, **J. R. Bence**, **M. B. Eldridge**, and **W. H. Lenarz**.

In press. An approach to estimating rockfish biomass based on larval production with application to *Sebastes jordani*. Fishery Bulletin.

**Schick, R. S.**

In press. Spatial correlation between bluefin tuna and sea surface temperature fronts. In: J. Breman (ed.), Marine geography: GIS for the oceans and seas. ESRI Press, Redlands, California.

**Silberberg, K. R.**, **T. E. Laidig**, **P. B. Adams**, and D. Albin.

In press. Analysis of maturity in lingcod (*Ophiodon elongatus*). California Fish and Game.

**Sogard, S. M.**, and B. L. Olla.

In press. Contrasts in the capacity and underlying mechanisms for compensatory growth in two pelagic marine fishes. Marine Ecology Progress Series.

Sponangle, S., G. Boehlert, R. K. Cowan, **C. B. Grimes**, M. J. Kingsford, J. M. Leis, K. Linderman, S. G. Morgan, J. L. Munro, J. Pineda, and A. Shanks.

In press. Predicting self recruitment in marine populations: biophysical correlates. *Bulletin of Marine Science*.

**Tomberlin, D.**

In press. Modeling California salmon fleet dynamics. In: Proceedings of the 2001 North American Association of Fisheries Economists meeting.

**Tomberlin, D.**

In press. The allocation problem in habitat restoration. In: Proceedings of the NMFS Habitat Restoration Cost workshop.

**Williams, E. H., and S. Ralston.**

In press. The distribution and co-occurrence of rockfishes (Family Scorpaenidae) over trawlable shelf and slope habitats of California and southern Oregon. *Fishery Bulletin*.

**Williams, T. H., and G. H. Reeves.**

In press. Ecological diversity and risk of extinction of Pacific salmon and trout. NOAA Technical Memorandum NMFS.

Wlasiuk, G., **J. C. Garza**, and E. Lessa.

In press. Genetic and geographic differentiation in the Rio Negro tuco-tuco (*Ctenomys rionegrensis*): distinguishing historical and contemporary gene flow. *Evolution*.

**Yoklavich, M., G. Cailliet, D. Oxman, J. P. Barry, and D. C. Lindquist.**

In press. Fishes. In: J. Caffrey (ed.), *Ecosystem changes in a California estuary: a characterization of Elkhorn Slough*.

**Yoklavich, M., G. Cailliet, R. N. Lea, H. G. Greene, R. Starr, J. deMarignac, and J. Field.**

In press. Deepwater habitat and fish resources associated with the Big Creek Ecological Reserve. *CalCOFI Reports* 43.

## PUBLICATIONS - 2002

Allman, R. J., and **C. B. Grimes**.

2002. Temporal and spatial dynamics of spawning, settlement, and growth of gray snapper (*Lutjanus griseus*) from the West Florida shelf as determined from otolith microstructures. *Fishery Bulletin* 100(3):391-403.

**Boughton, D.**, and U. Malvadkar.

2002. Extinction risk in successional landscapes subject to catastrophic disturbances. *Conservation Ecology* 6(2): article 2 [online: <http://www.consecol.org/vol6/iss2/art2>].

DeVries, D. A., **C. B. Grimes**, and M. H. Prager.

2002. Using otolith shape analysis to distinguish eastern Gulf of Mexico and Atlantic Ocean stocks of king mackerel. *Fisheries Research* 57:51-62.

Grover, A. M., **M. S. Mohr**, and M. L. Palmer-Zwahlen.

2002. Hook-and-release mortality of chinook salmon from drift mooching with circle hooks: management implications for California's ocean sport fishery. In: J. A. Lucy and A. L. Studholme (eds.), *Catch and release in marine recreational fisheries*, p. 39-56. *American Fisheries Society Symposium* 30.

**Hobson, T.**

2002. *Sebastes mystinus*: blue rockfish. In: M. S. Love, M. Yoklavich, and L. Thorsteinson, *The rockfishes of the Northeast Pacific*, p. 215-218. University of California Press.

**Klamath River Technical Advisory Team.**

2002. Ocean abundance projections and prospective harvest levels for Klamath River fall chinook, 2002 season. Klamath Fishery Management Council, Yreka, California.

Levin, P. S., and **C. B. Grimes**.

2002. Reef fish ecology and grouper conservation and management. In: P. F. Sale (ed.), *Coral reef fishes: dynamics and diversity in a complex ecosystem*, p. 377-389. Academic Press.

Love, M. S., **M. Yoklavich**, and L. Thorsteinson.

2002. *The rockfishes of the Northeast Pacific*. University of California Press. 405 p.

**MacCall, A. D.**

2002. Fishery-management and stock-rebuilding prospects under conditions of low-frequency environmental variability and species interactions. *Bulletin of Marine Science* 70(2):613-628.

**MacCall, A. D.**

2002. Sardine regimes and mesoscale structure (an integrative hypothesis). In: A. Bakun and K. Broad (eds.), *Climate and fisheries: the IRI-IPRC Pacific Climate-Fisheries Workshop* (Honolulu, 14-17 November 2001), p. 39-42. International Research Institute for Climate Prediction (IRI), Palisades, New York. IRI Publication IRI-CW/02/1.

**MacCall, A. D.**

2002. Status of bocaccio off California in 2002. Pacific Fishery Management Council, Portland, Oregon.

**MacCall, A. D.**

2002. Use of known-biomass production models to determine productivity of west coast groundfish stocks. *North American Journal of Fisheries Management* 22(1):272-279.

**MacCall, A. D., and S. Ralston.**

2002. Is logarithmic transformation really the best procedure for estimating stock-recruitment relationships? *North American Journal of Fisheries Management* 22(1):339-350.

**MacCall, A. D., and X. He.**

2002. Bocaccio rebuilding analysis for 2002 (final revised version). Pacific Fishery Management Council, Portland, Oregon.

**MacCall, A., and X. He.**

2002. Status review of the southern stock of Bocaccio (*Sebastes paucispinis*). National Marine Fisheries Service, Santa Cruz Laboratory, Santa Cruz, California. (Endangered Species Act report to the NMFS Southwest Region.)

**MacFarlane, R. B., and E. C. Norton.**

2002. Physiological ecology of juvenile chinook salmon (*Onchorhynchus tshawytscha*) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. *Fishery Bulletin* 100:244-257.

**MacFarlane, R. B., S. Ralston, C. Royer, and E. C. Norton.**

2002. Influences of the 1997-1998 El Nino and 1999 La Nina on juvenile chinook salmon in the Gulf of the Farallones. *PICES Scientific Report* 20:25-29.

**Ralston, S.**

2002. West coast groundfish harvest policy. *North American Journal of Fisheries Management* 22(1):249-250.

**Sakuma, K. M., F. B. Schwing, M. H. Pickett, D. Roberts, and S. Ralston.**

2002. The physical oceanography off the central California coast during May-June, 2000: a summary of CTD data from pelagic juvenile rockfish surveys. NOAA Technical Memorandum NMFS-SWFSC-318. 83 p.

**Salmon Technical Team.**

2002. Preseason report I: Stock abundance analysis for 2002 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Salmon Technical Team.**

2002. Preseason report II: Analysis of proposed regulatory options for 2002 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Salmon Technical Team.**

2002. Preseason report III: Analysis of council adopted management measures for 2002 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Salmon Technical Team.**

2002. Review of 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Williams, E. H.**

2002. The effects of unaccounted discards and misspecified natural mortality on harvest policies based on estimates of spawners per recruit. *North American Journal of Fisheries Management* 22(1):311-325.

## PUBLICATIONS - 2001

**Adams, P. B.**, and R. M. Starr.

2001. Lingcod. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 191-194. California Department of Fish and Game.

**Adams, P.**

2001. Salmon. In: H. A. Karl, et al. (eds.), Beyond the Golden Gate: oceanography, geology, biology, and environmental issues in the Gulf of the Farallones (full-length technical version), p. 146-149. U.S. Geological Survey Circular 1198.

**Adams, P.**

2001. Salmon. In: H. A. Karl, et al. (eds.), Beyond the Golden Gate: oceanography, geology, biology, and environmental issues in the Gulf of the Farallones (short general-audience version), p. 42-43. U.S. Geological Survey Circular 1198.

Carretta, J. V., J. Barlow, **K. A. Forney**, M. M. Muto, and J. Baker.

2001. U.S. Pacific marine mammal stock assessments: 2001. NOAA Technical Memorandum NMFS-SWFSC-317. 280 p.

Curry, B. E., and **K. A. Forney**.

2001. Report of the workshop on blood parameters for the assessment of stress in eastern tropical Pacific dolphins, January 30 and 31, 2001, Southwest Fisheries Science Center, La Jolla, California. NMFS SWFSC Administrative Report LJ-01-07. 22 p.

**Forney, K. A.**, S. R. Benson, and G. A. Cameron.

2001. Central California gillnet effort and bycatch of sensitive species, 1990-1998. In: E. F. Melvin and J. K. Parrish (eds.), Seabird bycatch: trends, roadblocks, and solutions, p. 141-160. University of Alaska Sea Grant Publication AK-SG-01-01, Fairbanks, Alaska.

**Garza, J. C.**, and E. Williamson.

2001. Detection of reduction in population size using data from microsatellite loci. *Molecular Ecology* 10:305-318.

**Grimes, C. B.**

2001. Fishery production and the Mississippi River discharge. *Fisheries* 26(8):17-26.

Henry, F. D. (revised by **D. E. Pearson**).

2001. Sablefish. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 390-392. California Department of Fish and Game.

**Hobson, E. S., and J. R. Chess.**

2001. Influence of trophic relations on form and behavior among fishes and benthic invertebrates in some California marine communities. *Environmental Biology of Fishes* 60:411-457.

**Hobson, E. S., J. R. Chess, and D. F. Howard.**

2001. Interannual variation in predation on first-year *Sebastes* spp. by three northern California predators. *Fishery Bulletin* 99:292-302.

**Howard, D.** (revised by **K. R. Silberberg**).

2001. Kelp greenling. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 183-184. California Department of Fish and Game.

Johnson, K. A., **M. M. Yoklavich**, and G. M. Cailliet.

2001. Recruitment of three species of juvenile rockfish (*Sebastes* spp.) on soft benthic habitats in Monterey Bay, California. *CalCOFI Reports* 42:153-166.

**Klamath River Technical Advisory Team.**

2001. An in-season recreational chinook harvest predictor for the Klamath River basin. Klamath Fishery Management Council, Yreka, California.

**Klamath River Technical Advisory Team.**

2001. Ocean stock size projections and prospective harvest levels for Klamath River fall chinook, 2001 season. Klamath Fishery Management Council, Yreka, California.

**Laidig, T. E.**

2001. Continental slope communities. In: H. A. Karl, et al. (eds.), *Beyond the Golden Gate: oceanography, geology, biology, and environmental issues in the Gulf of the Farallones* (full-length technical version), p. 185-191. U.S. Geological Survey Circular 1198.

**Laidig, T. E.**

2001. Continental slope communities. In: H. A. Karl, et al. (eds.), *Beyond the Golden Gate: oceanography, geology, biology, and environmental issues in the Gulf of the Farallones* (short general-audience version), p. 56-59. U.S. Geological Survey Circular 1198.

**Laidig, T. E., K. R. Silberberg, and P. B. Adams.**

2001. Age validation of the first, second, and third annulus from the dorsal fin rays of lingcod (*Ophiodon elongatus*). NOAA Technical Memorandum NMFS-SWFSC-306. 24 pp.

**Lenarz, W. H. (revised by D. E. Pearson)**

2001. Shortbelly rockfish. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 380-381. California Department of Fish and Game.

**MacCall, A. D.**

2001. Quantitative fish dynamics [book review]. *Journal of the American Statistical Association* 96(454):781.

**Moore, C. S.**

2001. Seasonal variability of extratropical North Pacific wind stress, Ekman pumping and Sverdrup transport. Master's thesis, Naval Postgraduate School, Monterey, California.

**Norton, E. C., R. B. MacFarlane, and M. S. Mohr.**

2001. Lipid class dynamics during development in early life stages of shortbelly rockfish and their application to condition assessment. *Journal of Fish Biology* 58:1010-1024.

**Pearson, D. E., and S. L. Owen (revised by D. Thomas).**

2001. English sole. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 384-385. California Department of Fish and Game.

**Prager, M. H., and M. S. Mohr.**

2001. The harvest rate model for Klamath River fall chinook salmon, with management applications and comments on model development and documentation. *North American Journal of Fisheries Management* 21(3):533-547.

**Ralston, S.**

2001. Yellowtail rockfish. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 372-373. California Department of Fish and Game.

**Ralston, S., and K. T. Oda.**

2001. Chilipepper. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 366-367. California Department of Fish and Game.

**Ralston, S., and W. H. Lenarz.**

2001. Widow rockfish. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 370-371. California Department of Fish and Game.

**Rau, G. H., S. Ralston, J. R. Southon, and F. P. Chavez.**

2001. Upwelling and the condition and diet of juvenile rockfish: a study using  $^{14}\text{C}$ ,  $^{13}\text{C}$ , and  $^{15}\text{N}$  natural abundances. *Limnology and Oceanography* 46(6):1565-1569.

**Sakuma, K. M., F. B. Schwing, M. H. Pickett, D. Roberts, and S. Ralston.**

2001. The physical oceanography off the central California coast during May-June, 1999: a summary of CTD data from pelagic juvenile rockfish surveys. NOAA Technical Memorandum NMFS-SWFSC-315. 86 p.

**Salmon Technical Team.**

2001. Preseason report I: Stock abundance analysis for 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Salmon Technical Team.**

2001. Preseason report II: Analysis of proposed regulatory options for 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Salmon Technical Team.**

2001. Preseason report III: Analysis of council adopted management measures for 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Salmon Technical Team.**

2001. Queets coho stock assessment. Pacific Fishery Management Council, Portland, Oregon.

**Salmon Technical Team.**

2001. Review of 2000 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.

**Spence, B. C., T. H. Williams, E. P. Bjorkstedt, and P. B. Adams.**

2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionary Significant Units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California. 111 p. (April 12, 2001 revision. Individual authors not specified in publication.)

Thomas, D. H. (revised by **A. D. MacCall**)

2001. Bocaccio. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 361-362, 554. California Department of Fish and Game.

**Thomson, C. J.**

2001. Human ecosystem dimension. In: W. S. Leet, et al. (eds.), California's living marine resources: a status report, p. 47-66. California Department of Fish and Game.

**Tomberlin, D.**, and J. Buongiorno.

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